## Report of the Noise Abatement Working Group of the Air Carrier Operations Subcommittee: Aviation Rulemaking Advisory Committee

The Noise Abatement Working Group held its first meeting in Washington, D.C. on June 27, 1991. This working group was assigned the following task: "Determine close-in (flaps down) and distant (flaps up) standard takeoff profiles and prepare material for incorporation into an Advisory Circular (these profiles were also to provide safe takeoff and initial climb performance criteria on a nation-wide basis)." During the first meeting, and the second on July 24, 1991, the working group reviewed the results of an informal joint FAA/industry task force which had previously studied the safety aspects of takeoff noise abatement procedures (see enclosure #1). The working group has discussed in detail the need for standardization and the establishment of minimum performance criteria for noise abatement takeoff profiles. The working group believes it has accomplished its assigned task and makes the following recommendations.

1. The minimum performance criteria of enclosure #2 should be incorporated into an AC.

2. The guidelines in enclosure #3 for selection of noise abatement takeoff profiles should be formalized.

3. In the interest of ensuring an orderly transition in the adoption of the performance criteria described in enclosure #2 WE ~~#1,~~ it is recommended that the FAA implement subsequent takeoff noise abatement profiles through air carrier Operations Specifications at an appropriate time. In addition, at airports where current air carrier operations are not compatible with the performance criteria in #2 WE ~~enclosure #1,~~ it is recommended that the FAA coordinate appropriate agreements and arrangements with the affected airports and, if appropriate, the affected air carriers.

4. Although some preliminary noise assessments have been accomplished with data from a B737-300 simulator, more work is needed to ensure that a process is available to asses whether any proposed takeoff profile does in fact offer sufficient noise abatement to justify its use. Accordingly, assessments of which departure profile is preferable from environmental standpoints, including noise abatement and energy conservation, require consideration of aircraft type and the variety of airport conditions including the locations of affected noise sensitive areas. In the interest of developing a method and data base for assessing the community noise benefit (or non-benefit) of the noise abatement takeoff profiles, it is recommended that the FAA

establish a working group to accomplish this activity.

5. The group recommends that the FAA assign a working group to investigate the possibility of utilizing a flight engineer in lieu of an automatic thrust advance system for the purpose of defining a minimum cutback thrust level.

   The working group also recommends that the FAA develop policy that ensures that operators may not use a normal procedure that prescribes the initiation of a power change (reduction) before attaining 800 feet AGL.

Schiphol
telephone: 31 20 605 9111
telex: 11526 FMHS NL
telex spares: 16208 AMFO NL
fax: 31 20 605 3200

Fokker Aircraft B.V. P.O. box 7600 1117 ZJ Schiphol, Holland

US Department of Transportation
Federal Aviation Administration
Office of Flight Standards AFS-1
800 Independence Ave, SW
Washington D.C.
U.S.A.
Att. Mr. Wes Euler

| your letter/reference | our reference | date |
|---|---|---|
| | 173-91 | 24th April 1991. |

Subject: Noise abatement cutback, revision to draft AC 91-53A.

Ref.1. Joint FAA/Industry take-off noise abtement meeting on March 13, 1991.

2. FAA letter dated May 15, 1989 to Fokker signed by ANM-200/Mr. T.J. Howard.

3. Fokker letter EQ/90-0387/AO/MA dated March 29, 1990 to the FAA.

4. FAA letter dated April 19,1990 to Fokker signed by Mr. Daniel C. Beaudette Director Flight Standards Service.

5. Fokker datafax to FAA/Mr. Wes Euler dated 21 March 1991 Take-off noise levels Fokker 100.

Dear Mr. Euler!

During ref. 1. meeting Fokker took an action item to explain why we were not in favour of raising the cutback altitude to 800 ft minimum. The following outlines our criticism in 6 chapters, i.e. Approvals, 800 ft cutback altitude, Noise, Safety, Future and Summary/conclusion.



domiciled at Amsterdam
trade register Haarlem no. 37954
trade register Amsterdam no. 156913
address. Schipholdijk 231, Schiphol-Oost

Algemene Bank Nederland N.V., Amsterdam, no. 54 .03.35.509

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A. Approvals

The Fokker 100 Noise Abatement Profile (NAP) has been certified by RLD & FAA for Orange County (SNA) only, see App. I.
This was fully in line with a basic understanding from FAA that, subject to verification, the system could be approved, see ref. 4.

Raising the cutback altitude to 800 ft would
- make the above approval useless both for E and AA class operations, at Orange County
- make most of the Fokker 100 NAP features redundant or even penalize the Fokker 100 more than other aircraft not having such a system, for explanation see item C.

B. 800 ft Cutback altitude.

As for the working group recommendations attachment 2 - pages 4 thru 6 on initiating altitude, we believe that 800 ft is not necessarily safer than 400 ft, because this has to be weighed against how the cutback is performed, the particular aircraft configuration, equipment & systems layout, etc.

A review of the additional reasons 1 thru 8 of att. 2-4/5 with respect to the Fokker 100 yields the following:

1. A Fokker 100 usually achieves a stable flight path at 100-200ft (YES, IT IS A VERY EASY AIRCRAFT TO FLY!)
After cutback, the system controls to approx 1100ft/min regardless of partial thrust loss or down draft.

2. The F100 has a fully integrated windshear escape guidance also available on autopilot with automatic firewall thrust selection between lift off and 1500 ft.
Wingtip vortex encounters leading to speedloss are fully covered thru the NAP protection systems, see also item D.

3&4 Fokker 100 AFCAS consists of a high integrity monitoring system that allows category 3B autolands and redundant take off's from 35 ft.
Autopilot capability from 35 ft gives the crew maximum capability to excercise external vigilance.

We find it inconceivable that a hightech auto flight control system - with all its pre engage safety checks and post engage monitoring can be used for an automatic landing but not immediately after take-off.
Please note that on the Fokker 100 it is not possible to engage into unsafe conditions.

5. The Fokker 100 NAP does not require clean-up before thrust reduction. In addition, flaps zero will be the preferred configuration because it has the best L/D ratio, hence leads almost always to lowest noise on the ground.

6. The Fokker 100 avionics system allows FMS NAV to be armed on the ground. If such a take off is performed NAV auto engages at 35 ft providing further relief to the pilots.

7. While it is true that Fokker 100 NAP requires extra training we firmly believe this to be minimal because of the simplicity, the clear task allocation PF-PNF and the fact that the emergency procedures are the same as normal emergency procedures, see also item D.

8. Between 500 & 1000ft, TCAS has full operational capability excluding descend commands. It is true that full TCAS incl. descent commands will be available earlier (~7 sec. at 1000ft on Fokker 100) however the safety benefit of this is doubted, since the least likely to occur are TCAS descend commands because of the vertical speeds achieved after liftoff. Noise Abatement Takeoff performed with the Fokker 100 results in a minimum vertical speed of 1100fpm, achieved at approx. 800ft AAE. Therefore, TCAS capability can hardly be a reason for the cutback altitude to be 800ft.

C. Noise.

As already outlined in our fax, ref.5, raising the cutback altitude to 800 ft puts medium by pass ratio engines (the TAY = 3:1) at a competitive disadvantage especially when close to the airport.
% See. APP.II.

Another big disadvantage of a minimum cutback altitude of 800ft instead of 400ft is that a lot of flexibility to optimize the NAP procedure for the relevant local situation is lost. We have added 75 dB noise footprints for representative Fokker 100 take off weights for 85000 & 90.000lb, i.e. average loadfactors for 300 and 500nm trips,
% See APP. III.
While the areas are rather close, the shapes are not. When the noise-sensitive area's are located close to the airport, a cut-back altitude of 400 instead of 800ft will provide substantial noise benefit's.
This is the very reason that we incorporated in our NAP system the possibility to safely initiate cutback at any desired altitude starting from 400 ft.

Finally, in order to permit safe cutback at 400ft, the Fokker 100 NAP system incorporates safety features beyond Draft AC 91-53A. One of these features results in a noise penalty compared to aircraft not having similar protection, as we will explain:

In the Fokker 100 NAP system, the thrust cutback is controlled to follow the pilotcontrolled pitch attitude, with the result that the NEPR target is reached at approx. 400ft above the thrust cutback initiation altitude. The proposed rules with 800 ft minimum cutback altitude would not require the thrust cutback to be automatically controlled. A manually set cutback thrust, and hence the corresponding noise reduction, would be achieved more rapidly, e.g. at 200 ft above cutback initiation. In order to avoid a noise penalty compared to aircraft using manual cutback, the automatic feature would have to be removed, which in our view would reduce safety.

D. Safety

A proper understanding of the safety issues involved has to start with the Fokker 100 Flight Deck Design objectives. The most important are:

1. Simple and straight forward operation.
2. Keep the pilot in the loop.

The NAP procedure has been summarized in App. IV.

% App. IV. The NAP procedure reviewed against the above principles gives:

Ad 1 - NAP procedure itself is simple and straight forward. Apart from arming the system on the Flight Mode Panel (NAP button) the only other action is pushing Climb (CLB) on the (MFDS) thrustrating panel.

- Clear task allocation PF-PNF

- Standard emergency procedures

For these last two items Crew Resource Management has been
% implemented as can be observed from the Flight Manual text, see app.V.

Ad 2 - The pilot is kept in the loop because

- Thrust cutback "NEPR" value is displayed on the MFDU throughout NAP-take-off

% App. VI Summarizes the NEPR target computation, being automatic & continous based on all relevant parameters.

- NAP mode annunciation on the Flight Mode Annunciation (FMA) on EFIS for normal, abnormal and emergency situations.

% App. VII Outlines three abnormal/emergency situation including presentation to the pilot as follows:

Sht.1: Aircraft flies in vertical speed with NEPR (noise abatement thrust) established, speed is open in second phase when speed, which was V2 + 10, is lost (eg due to windshear) i.e. less than V2 + 5, the system automatically reverts to speed on throttle.

Sht.2: NAP is armed but not active. The LH engine fails the system automatically disarms NAP, the RH engine automatically to controls to the autoselected T.O. thrust limit.

Sht.3: NAP is active, the LH engine fails. NAP is deactivated. Automatic reversion to TO mode follows. Again this is clearly indicated to the pilot both on the FMA and on the MFDS (engine indication. Actual Speed (V2 + 10) becomes reference.

The above system not only fully meets draft AC.91.53A, but has several safety features that go beyond this draft AC as follows.

- After cutback, vertical speed control ensures a constant rate of climb of approx 1100 ft/min regardless of partial thrustloss, down draft or windshear. For protection mechanism's summary see app. IV sht. 3.
- Thrust cutback follows pitch attitude causing a controlled thrust reduction. NEPR target is achieved at approx 400 ft above cutback altitude.
- Engine failure & windshear procedures are identical for both normal and NAP take-off.
- Autopilot capability is available to perform NAP.

In view of the foregoing Fokker firmly believes its NAP system with cutbacks starting at 400ft, to be inherently more safe than cutback systems and procedures at 800ft following the suggestions of the noise working group.

This is primarily because of

- The extra safety features as described before.
- The low workload, which has been reduced to the absolute minimum within the current certification requirements, see app. VIII.

In fact Fokker believes that NAP take-off with a Fokker 100 at 400ft cutback altitude is safer than a take-off performed with most other airplanes using 800ft cutback altitude.

E. Future.

Fokker believes that the revised noise take-off rules as proposed by the noise working group discourages future developments. The fact that no credit is given for advanced and/or redundant systems, other than automatic thrust restoration following engine failure, is a significant point in this respect.

F. Summary & Conclusion.

Fokker believes that, apart from serious economic impact for Fokker - the NAP system was extensively modified following ref.2, which now seems at least superfluous - the new proposed rules are counter-productive to the noise groups intentions for two reasons, viz.

a. 800ft cutback favours high bypass ratio engines more than medium/low bypass ration engines.
It should be noted that the stage 3 noise rules can be beaten by large margins by both types of engine aircraft combinations!

b. The net safety gain by raising the cutback altitude to 800ft will be more than offset by the negative safety aspects of mainly manual cutback procedures as now proposed, since there is no incentive to incorporate advanced/redundant systems.

Sincerely Yours

A.J.Ovaa
Manager Quality Assurance &
Airworthiness Engineering

R.den Hertog
Chief Engineer F28/Fokker 100

# SUMMARY OF REPORT ON JOINT FAA/INDUSTRY TAKEOFF NOISE ABATEMENT WORKING GROUP

<u>PROBLEM</u>: Because of unique runway/community situations and varying performance and noise characteristics of different aircraft, there have been increasing pressures to use nonstandard or special takeoff noise abatement procedures. The lack of standardization generally has a negative effect on safety. Although a nonstandard procedure may not have a significant effect when considered alone, potentially there is a negative effect on safety when these procedures vary from airport to airport and aircraft to aircraft. There is a need to address these potentially negative effects and to ensure that adequate safety levels are maintained. The attachments to this summary report on the activities and recommendations of the joint FAA/Industry working group that was formed to address this problem.

<u>ORGANIZATION OF THIS REPORT</u>: This report is organized in a series of attachments as follows:

- Attachment 1 contains the minutes of the working group's meetings. The minutes are presented first as they provide some background for the recommendations.

- Attachment 2 contains the recommendations and the reasons for the recommendations of the working group.

- Attachment 3 provides samples of single event noise profiles and noise contours for the recommended procedures with various aircraft types and engine combinations.

- Attachment 4 contains copies of the written comments on the FAA's initial proposal and counter proposals which are submitted by industry. The last document of this attachment is a copy of the FAA's initial proposal.

- Attachment 5 contains copies of the results of certain noise abatement departure profile tests conducted by the working group.

<u>OVERALL NOISE RELIEF BENEFITS</u>: The current Advisory Circular 91-53, Noise Abatement Profile, provides for only one standard noise abatement departure profile. This procedure is equivalent to the "distant procedure" recommended by the working group. The working group recommendations include two standard procedures, one of which provides relief for noise sensitive areas relatively close to the end of the runway, and the other, relief for noise sensitive areas that are more distant from the runway end. The recommendations also provide for deeper thrust cutbacks for aircraft with high bypass ratio engines. Current AC 91-53 provides for only a reduction to normal climb thrust with high bypass engines.

RECOMMENDATIONS: The working group's recommendations and reasons for those recommendations are in Attachment 2 of this report. In summary the working group recommends the following:

- That two basic (standard) noise abatement procedures, a close-in and a distant procedure, be adopted for nationwide use. The appropriate procedure for a particular situation depends on operating gross weights, runway lengths, and locations of the noise sensitive area.

- That the criteria established for noise abatement procedures be applicable to all types of turbojet aircraft over 75,000 pounds.

- That the minimum altitude for initiating the procedure should not be less than 800 feet above field elevation (AFE).

- That for aircraft without automatic thrust cutback and restoration systems, the cutback thrust should not be less than that necessary to maintain the engine-inoperative climb gradients specified by FAR 25.111(c)(3).

- That for aircraft with automatic thrust cutback and restoration systems, the cutback thrust should not be less than that necessary to maintain an engine-inoperative climb gradient of at least 0% if the automatic thrust restoration system failed to function properly.

- That the noise abatement thrust reduction be maintained until at least 3,000 feet AFE or until past the noise sensitive area.

- That these criteria for the two noise abatement procedures be made mandatory through operations specifications.

MAINTENANCE OF ADEQUATE SAFETY LEVELS: The following elements of the recommendations ensure that adequate levels of safety are maintained.

- The requirement for only two basic procedures that are applicable to all types of turbojet aircraft provides for standardization of operational procedures and flightcrew training and enhances retention of flightcrew proficiency.

- The establishment of a minimum noise abatement initiating altitude of 800 feet provides for reasonable flightcrew workloads for a variety of takeoff weights and ambient temperatures as well as a safety margin (altitude) should windshear, wake turbulence or other adverse weather condition be encountered after the thrust cutback or configuration change is initiated.

- The establishment of a minimum level for thrust reduction ensures a positive rate of climb in the event of an engine failure without pilot intervention (protection for insidious engine failures and other emergency scenarios). This minimum level of thrust reduction also provides sufficient thrust over drag margins to permit normal maneuvering at low airspeeds and altitudes. It also limits the amount of pitch-over during a thrust cutback thereby reducing flightcrew workloads associated with a pitch over to an acceptable level.

ATTACHMENT 1
MINUTES OF MEETINGS
JOINT FAA/INDUSTRY
NOISE ABATEMENT
WORKING GROUP
FEBRUARY 1, 1991

General: During the June 19, 1990 joint FAA/Industry meeting on Aircraft Noise Abatement, the FAA presented a proposed resolution to serve as a "strawman" or as a basis for initiating discussion and exploring alternative approaches. All persons attending the meeting were invited to submit comments on the FAA's proposal or to submit any counter or alternative proposal that they believed would resolve the problem. It was decided to select a smaller working group to study these comments or alternative proposals and to develop recommendations for consideration by the larger Joint FAA/Industry Group. It was also decided that the working group should consist of representatives from the pilot associations, representatives from the airlines, and an FAA representative. The manufacturers elected not to provide a representative for the working group but agreed to provide any assistance requested by the group. The following personnel were selected as members of the working group.

Gene Frank- Senior Director, Flight Standards, Northwest Airlines

Scott Griffith- Noise Representative, Allied Pilots Association

Tom McBroom- Specialist Flying Engineering, American Airlines

Joe Schwind- Deputy Director Air Safety, Air Line PIlots Assoc.

Don Jones- Flight Manager-Standards, United Airlines

Bill Phaneuf- Staff Engineer, Air Line Pilots Association

Larry Taylor- Check Airman and Noise Specialist, America West Airlines

Dick Deeds- Chairman ALPA Noise Committee, Air Line Pilots Assoc.

Wes Euler- Assistant Manager, Technical Programs Division, FAA

Summary of Comments and Alternative Proposals: Attachment 4 contains all of the written comments concerning the FAA's proposed resolutions as well as alternative proposals submitted by industry representatives attending the June 19, meeting. The following is a brief summary:

McDonnell Douglas: Agreed in concept for the need to establish three standard takeoff procedures with reservations about requiring automatic cutback and thrust advance systems and modified GPWS capabilities for existing fleets. Believes future systems can be fully automatic, safe and reliable and provide cutback capability for 0% engine-out gradients. Does not support action that negates presently approved procedures. Suggests that this groups efforts be integrated with the efforts presently being formulated by the Aviation Systems Capacity Task Force Noise Working Group.

Fokker Aircraft: Does not disagree with the concepts in the FAA's proposed resolution. Offered recommendations concerning speed requirements, sequence of thrust and flap selection, reduced thrust takeoffs, and the alert eye position. Disagrees with the requirement for the pilot flying being able to perform the maneuver without assistance. Believes crew coordination essential to provide for minimum pilot workloads. Recommends that a specific section be developed to address airworthiness requirements such as performance, handling qualities, failure analysis, etc. and another section dealing with operational test and evaluations to make it clear as to whether FAA Flight Standards or Airworthiness should be approached for approval.

Boeing: Offered an alternative proposal as well as comments and recommendations to the FAA's proposal. Recommendations concerned speed requirements, initiating altitudes, tying automatic thrust recovery systems to Part 25.111 gradients instead of altitude, tying automatic thrust cutback systems to altitude for crew workload purposes, GPWS requirements, provisions to arm an automatic pilot or a flight guidance system, thrust setability, aircraft controllability and flight guidance systems. The alternative proposal contained two primary elements: (1) Cutbacks below 1,000 feet AGL and/or below Part 25.111 engine inoperative gradients would not be allowed, and (2) airport noise rules based on noise monitors closer than the distance necessary for airplanes to become stabilized at cutback power after reaching 1,000 feet AGL would not be allowed. Emphasized that element (2) would have to be an essential ingredient to the viability of the alternative proposal.

Air Transport Association: Offered no specific comments on the FAA's proposed resolution. Instead offered an alternative proposal consisting of the following:

(a) CLOSE-IN (less than 3nm nominal):
    1. Takeoff and climb to 1,000 feet AAE.
    2. Pitch not to be exceed manufacturer's recommended maximum pitch attitude.

3. At 1,000 feet reduce thrust to not less than Part 25.111 engine inoperative climb gradients or 0% gradients for aircraft equipped with auto thrust recovery systems. Maintain takeoff configuration and $V_2$ + 10-20 knots.

4. Continue climb at $V_2$ + 10-20 knots to 3,000 feet then set climb thrust and accelerate while retracting flaps on schedule.

(b) FAR-OUT (beyond 3 miles nominal)

1. Takeoff and climb to 1,500 feet AAE.

2. Pitch not to exceed manufacturers recommended maximum pitch attitude.

3a. HIGH BYPASS ENGINES

At 1,500 feet set climb thrust, accelerate to $V_{ZF}$ while retracting flaps on schedule.

3b. LOW BYPASS ENGINES

At 1,500 feet accelerate to $V_{ZF}$ while retracting flaps on schedule and then set climb thrust.

4. Climb at $V_{ZF}$ to 3,000 feet AAE and then initiate normal climb profile.

ATA emphasizes that Stage III aircraft provide the highest level of noise technology currently available, consequently, local use restrictions should not be permitted to discriminate against any aircraft which qualifies as Stage III. Airports and/or communities must not impose noise restrictions which would necessitate thrust cutbacks below 1,000 feet.

<u>First Working Group Meeting</u> - The first working group meeting was held in Washington, DC on July 24 and 25, 1990. The group reviewed in detail the comments and proposals that were submitted in response to the FAA's proposal. It was then agreed to discuss in detail all facets of the noise abatement vertical profile. To ensure an orderly discussion and mutual understandings, the noise abatement profile was segmented as follows:

(a) Takeoff segment = Brake release to 1st transition.
(b) First transition segment = Thrust cutback and/or Flap retraction.
(c) Reduced Noise segment = Portion of climb out at reduced thrust and/or constrained airspeed.
(d) Second transition segment = Reestablishment of normal climb (thrust, configuration, and/or airspeed).
(e) Enroute climb segment = Normal climb procedures to altitude.

The working group considered the following factors and their related effects, as appropriate, for each of the segments of the takeoff profile. The effects and the interrelationships of these effects were discussed in detail as to their impact on the flight path, safety of operations, and the noise benefits obtained throughout the takeoff profile.

(a) Max rated takeoff thrust - Reduced thrust takeoff.
(b) Takeoff rotation rates and techniques.
(c) Initial climb pitch attitudes.
(d) Altitudes to initiate 1st transition segment.
(e) Flight path (pitch angle) changes.
  - Amounts of change
  - Techniques for performing change
  - External visual capabilities - Alert eye position
  - Flightcrew workloads
(f) Flight guidance considerations
(g) Aircraft performance
  - Normal climb gradients - All engine/engine inop
  - Part 25.111 gradients - All engine/engine inop
  - 0% gradients - all engine/engine inop
  - Minus gradients - all engine/engine inop
  - Flaps up - Flaps down
  - Turns
  - Power reserves
(h) Thrust reduction and thrust reapplication techniques
(i) Thrust setability considerations
(j) Auto thrust reduction systems
  - Arming and inhibiting mechanisms.
  - Pilot single action
(k) Auto thrust restoration systems
(l) Crew alerting systems (GPWS)
(m) Induced failures resulting from power and configuration changes, and mode switching.
(n) Aircraft emergencies
(o) Aircraft controllability considerations
(p) Air traffic see and avoid considerations - TCAS
(q) Obstacle clearance requirements
(r) External phenomena
  - Wake Vortex
  - Wind Shear
  - Icing
  - Turbulence
  - IMC
(s) Navigation and ATC clearance considerations
(t) Pilot comfort levels - Pilot performance - Pilot distractions
(u) Passenger comfort.

As the group discussed the effects of the above factors for each segment of various noise abatement procedures, it became apparent that the more a procedure (or factor) diverged from a normal takeoff profile, the more critical the effects become with respect to safe flight operations. As the procedural diversions became greater, the effects tended to compound and become more complex. Although the use of automatic systems would appear to alleviate this compounding to a certain extent, the automatics themselves introduce a different set of effects and workloads associated with monitoring performance of the automatic systems. During the first meeting the group did not reach consensus as to when a particular effect, set of effects, or compounded effects adversely impacted safety of operations.

The group also discussed the factors and the related noise relief provided during each segment of various noise abatement profiles. The group had at its disposal the results of a 1984 FAA test conducted with Stage II aircraft. The group did not have data for Stage III aircraft to make comparisons or to understand the amount of noise relief provided by Stage III aircraft during a particular segment of a noise abatement profile. In general, however, the group believed that the noise profiles and footprints of Stage II and Stage III aircraft would be similar in shape, but that for any particular segment of the takeoff profile, the amount of noise relief might be significantly different for the Stage III aircraft. Questions continually raised were; does a deep thrust cutback in Stage III aircraft result in noise relief benefits throughout all segments of both close-in and distant noise abatement procedures, is the noise relief pattern produced by Stage III similar to Stage II aircraft, and are the results consistent for various takeoff weights? The group believed it needed more information concerning these questions before developing recommendations for standard close-in and distant noise abatement procedures suitable to both Stage II and Stage III aircraft. The answers to these questions are also important when it is understood that the objective is to develop standard noise abatement procedures to be used routinely at numerous airports and runways nationwide.

Don Jones of United Air Lines volunteered to conduct a series of Stage III test in a UAL B-737-300 simulator which is outfitted with a computerized noise evaluation program. This program records aircraft performance parameters and noise levels (SELDB) versus distance from brake release. The group agreed upon the series of takeoff profiles to be flown in these tests (see Attachment 5). ALPA and APA pilots volunteered to participate in the tests. The group agreed to reconvene after the tests were completed.

**Second Working Group Meeting**: The second working group meeting was held in Washington, DC on November 14 through 16, 1990. The first part of the meeting was spent reviewing the results of the tests conducted in UAL's B-737-300 (see noise profiles in Attachment 5). Although the UAL data was not displayed in the same manner as the 1984 FAA data, it was evident that the Stage III aircraft were substantially less noisy than Stage II aircraft. It was also evident that a deep thrust reduction in a Stage II results in a greater proportionate noise reduction as a comparable thrust reduction in a Stage III aircraft. The results of the tests, however, indicated that although the amounts and proportions of noise reduction obtained through deep thrust cutbacks were noticeably different, the basic patterns of noise reduction between Stage II and Stage III aircraft were similar.

The group then reviewed past discussions on the factors associated with noise abatement procedures and their effects on the safety of flight operations. The group concluded that only two basic (standard) takeoff noise abatement procedures (one close-in and one distant) applicable to all types of turbojet aircraft over 75,000 pounds should be adopted. The group believes this approach is appropriate because of the dramatic changes within the air transportation industry that are associated with rapid growth, new technology, and airport/airspace capacity problems. Other reasons include the following:

1. The rapid influx of new aircraft as well as new and different flight guidance and control systems can and has led to significantly different procedures and flightcrew workload requirements for each aircraft type. For air carriers with mixed fleets, different noise abatement procedures for each aircraft type complicates the standardization of flightcrew training, makes it difficult to overcome ingrained human habit patterns and adversely affects retention of flightcrew proficiency.

2. Many air carriers experience rapid turnover of flightcrew members from one aircraft type to another and from one flightcrew position to another. This often results in flightcrews having a low flight time experience in a particular aircraft type or crewmember position. To permit different noise abatement procedures between aircraft types exacerbates the problems associated with low flight time experience and crew pairing for a particular aircraft type.

During the balance of this meeting, the group began to formulate their recommendations and the reasons for those recommendations

Third Working Roup Meeting: The third working group meeting was held in Washington DC on December 19, 1990. During this meeting, the working group finalized their recommendations and discussed options for the drafting and presentation of the recommendations to the larger joint FAA/Industry Noise Abatement Group. The recommendations are in Attachment 2.

## ATTACHMENT 2

## JOINT FAA/INDUSTRY NOISE WORKING GROUP

## RECOMMENDATIONS

<u>BROAD OBJECTIVES</u>: Before formulating recommendations, the working group reviewed the objectives on which the recommendations would be based. These objectives are summarized as follows:

1. To enhance safety of flight operations while providing noise relief:

a. To enhance safety through standardization by establishing national noise abatement procedures. To achieve this objective it is necessary to prohibit proliferation of numerous nonstandard noise abatement procedures tailored for unique airport/community environments.

b. To establish noise abatement procedures that limit the number of takeoff profiles that the flightcrew must be trained to perform.

c. To establish minimum operational criteria (a floor) and make these criteria mandatory, through Operations Specifications.

d. To discourage noise measurements from being used as a means for controlling airport access which has caused operators and pilots to use unique and questionable procedures to remain competitive.

2. To provide effective noise relief in an equitable manner:

a. To provide maximum noise relief to communities in a manner that is consistent with safe operating practices and that are acceptable to the aviation industry as a whole.

b. To discourage the use of locally developed noise measurement programs which induce operators to service those communities with available Stage III aircraft, which inturn results in increased use of the noisier Stage II aircraft at other communities.

**Working Group Recommendation on the Number of Acceptable Noise Abatement Procedures**: Conceivebly an infinite number of noise abatement procedures could be devised and rationalized because of the following factors:

1. The range of differences in operational performance and noise characteristics between aircraft types and the variety of takeoff configurations within aircraft types.

2. The range of takeoff weights dictated by flight leg length.

3. The wide range of ambient temperatures expereinced in nationwide operations.

4. The many different community and airport physical layouts with unique environmental situations and the wide range of runway lengths.

The working group considered these factors during their initial efforts to develop a flexible set of criteria which would provide both optimal noise relief and safe flight operations. In addition, the group believes there have been recent and dramatic changes within the industry that must be taken into account in the development of standard noise abatement procedures. These changes include the rapid growth of some air carriers; mergers of aircraft fleets, flightcrews, and operational procedures of other air carriers; and new procedures and systems designed to improve airport and airspace capacity. Other factors that were considered include the following:

1. The rapid influx of new technology aircraft and flight guidance and control systems has resulted in different procedures and flightcrew workload requirements for each aircraft type. To also have significantly different noise abatement procedures for each aircraft type in a fleet, complicates the standardization of flight crew training, increases the difficulty in overcoming ingrained human habit patterns, and adversely affects retention of flightcrew proficiency.

2. Many air carriers experience either continual or periodic turnovers of flightcrew member from one aircraft type to another and/or from one flightcrew position to another. This often results in flightcrews having a low

flight time experience in a particular aircraft type and/or flightcrew member position. To provide for different noise abatement procedures between aircraft types or different procedures for different airports exacerbates the problems associated with low flight time experience and appropriate crew pairing.

Because of these factors, the working group recommends that minimum criteria should be established which would permit no more than two basic types of noise abatement procedures. These procedures would be applicable to all types of turbojet aircraft over 75,000 pounds. The basic types of noise abatement procedures recommended are the "close-in" and the "distant" procedures (see recommendations for minimum criteria for noise abatement procedures).

**WORKING GROUP RECOMMENDATION ON INITIATING ALTITUDE**: For the purpose of this discussion the "initiating altitude" is the altitude in the initial climb after takeoff in which the first action is taken to initiate a thrust cutback or to initiate flap retraction with a subsequent thrust cutback for the purpose of noise reduction.

During the takeoff maneuver, the dynamics of rapidly changing events such as rotation, establishment of initial pitch attitude, gear retraction, airspeed control, and other configuration changes, make the initial segment of the takeoff maneuver a critical phase of flight. During this segment there are high flightcrew workload requirements which include stabilization of the flight path as well as traffic vigilance, situational orientation, instrument scan, and awareness of aircraft performance. To encompass the spectrum of aircraft types, takeoff weights, configurations, and to provide for reasonable flightcrew workloads, a minimum altitude should be specified for initiating other actions for the purpose of noise abatement which compound flightcrew workloads. The working group believes that a minimum altitude of 800 feet would provide reasonable assurance that most aircraft types and flight crews can achieve a stable flight profile under relatively normal workload levels before initiating a thrust cutback or flap retraction. The group also recommends that 800 feet should be established as the minimum initiating altitude for the following additional reasons:

1. A predominant and well established safety factor is the altitude gained immediately after liftoff. Altitude equates to time, airspeed, obstacle clearance, reduced flightcrew workload and concentration inside the cockpit, and usually increased external visibility.

2. The effects of windshear and wingtip vortex encounters are less critical at altitudes above 800 feet.

3. Achievement of flight path stability at altitudes below 800 feet enhances the flightcrew ability to exercise external vigilance.

4. Power and configuration changes and mode switching initiated below 800 feet increase exposure to system failures and the associated risks, earlier and at lower altitudes. This is especially true when such failures are induced by power changes, configuration changes and mode switching. Minimizing the failure risk while the flightcrew is establishing stabilized flight is more acceptable. In most cases the aircraft flight path will be stabilized by 800 feet.

5. The level of 800 to 1,000 feet AFE is generally accepted by the air carrier industry as the standard clean up altitude for obstacle clearance purposes at most airports. Using a minimum of 800 feet, rather than a lower altitude, minimizes the need for changing the initiating altitude for obstacle clearance purposes at other airports.

6. The level of 800 to 1,000 feet AFE permits time for the flightcrew to initiate navigation tasks before performing power and configuration changes.

7. The altitude of 800 to 1,000 feet closely represents the altitude used within industry for normal operating procedures, thereby avoiding a requirement for special training.

8. The full operational capability of TCAS is not available below 1,000 feet. With the establishment of the 800 foot minimum thrust cutback criteria, full TCAS capability is available sooner and closer to the airport.

## WORKING GROUP RECOMMENDATION ON AMOUNT OF THRUST REDUCTION:

Any thrust cutback after the aircraft has been established on a stablized flight path requires at least some flightcrew action to restablize the flight path. The greater the cutback, the greater the flightcrew workload required to stablize pitch attitude, airspeed, and thrust setting. The amount of flight path destabilization caused by a thrust cutback can vary significantly depending on flight conditions such as takeoff weight, ambient temperatures, and density altitudes. For example, a thrust cutback for noise abatement purposes when the aircraft is at a low gross weight in a cold temperature causes a much greater workload (sometimes unexpected) than when the aircraft is at a higher weight in a warmer temperature. The flightcrew workload can also be increased and compounded at anytime by external influences such as navigation, ATC, and outside traffic viglance requirements, and weather related conditions including turbulence, ragged or intermediate cloudiness, temperature inversions, windshear, precipitation, icing, etc.

In addition if standard close-in and distant noise abatement procedures involving deep thrust cutbacks are adopted, their use will become more frequent at many different airport/runway environments throughout the nation and at foreign locations. Because of the effect that a thrust cutback has on flightcrew workload and the chances that this effect may be more frequently compounded by external influences due to the increased usage of such procedures, the working group believes that a minimum criterion must be established for the amount of thrust that can be cutback. This minimum criteria must assure manageable workloads for the average flightcrew experience and capabilities without extraordinary training requirements.

The working group also believes that a minimum criterion for the amount of thrust cutback must be established to ensure that sufficient performance margins and reserves are available throughout the noise abatement procedure. This minimum criteria must account for factors which degrade aircraft performance under normal flight conditions such as bank angles up to 30 degrees, windshear, temperature inversions, and less than scheduled engine power. The minimum criteria must also account for degraded aircraft performance resulting from emergencies such as an engine failure.

The working group believes and recommends that the following minimum criteria should be established for the amount of thrust reduction permitted for noise abatement procedures.

1. <u>Without Automatic Thrust Restoration Systems</u>: The amount of thrust reduction must not be less than the thrust necessary, in the event of an engine failure, to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3). This minimum thrust setting must be determined without considering the subsequent addition of thrust on the remaining engine(s) from a pilot action.

2. <u>With Authomatic Thrust Restoration Systems</u>: The amount of thrust reduction must not be less than the thrust necessary, in the event of an engine failure, to maintain a takeoff path engine-inoperative climb gradient of not less than 0%. This minimum thrust setting must be determined without considering the subsequent addition of thrust on the remaining engine(s) from an automatic thrust restoration system. In addition it must be shown that it is improbable that the thrust restoration system will fail to restore at least sufficient thrust to maintain the engine-inoperative gradients specified by FAR 25.111(c)(3) without any pilot intervention.

**WORKING GROUP RECOMMENDATIONS ON MINIMUM CRITERIA FOR NOISE ABATEMENT PROCEDURES**: The following minimum criteria are recommended for the close-in and distant takeoff noise abatement procedures:

A. CLOSE-IN NOISE ABATEMENT PROCEDURE (MINIMUM CRITERIA):

1. An initiating altitude of not less than 800 feet AFE must be used.

2a. For aircraft <u>without</u> automatic thrust restoration systems installed, cutback thrust reduction shall be less than the thrust necessary to maintain the takeoff path engine - inoperative climb gradients specified in FAR 25.111(c)(3). If manual thrust reductions are used, the thrust shall be reduced at a normal rate.

2b. For aircraft <u>with</u> automatic thrust restoration systems installed, cutback thrust reduction shall not be be less than that necessary to maintain a takeoff path engine-inoperative climb gradient of not less than 0%. The rate of thrust reduction shall be at a normal rate.

3. Maintain at least Vzp to not less than 3,000 feet above field elevation or until past the noise sensitive area.

NOTE: Vzp = Minimum maneuvering speed for configuration.

4. Resume normal procedures.

B. DISTANT NOISE ABATEMENT PROCEDURE (MINIMUM CRITERIA):

1. An initiating altitude of not less than 800 feet must be used.

2. Retract flaps/slats while accelerating on individual aircraft schedule.

3a. For aircraft _without_ automatic thrust restoration systems installed, after flap retraction or at a partial flap setting, if appropriate, set cutback thrust. Cutback thrust reduction shall not be less than that necessary to maintain the takeoff path engine inoperative climb gradients specified in FAR 25.111(c)(3). If manual thrust reductions are used, the thrust shall be reduced at a normal rate.

3b. For aircraft _with_ automatic thrust restoration systems installed, after flap retraction or at a partial flap setting, if appropriate, initiate cutback thrust. Cutback thrust reduction shall not be less than that necessary to maintain a takeoff path engine-inoperative climb gradient of not less than 0%. The rate of thrust reduction shall be at a normal rate.

4. Maintain at least Vzp to not less than 3,000 feet above field elevation or until past the noise sensitive area.

NOTE: Vzp = Minimum maneuvering speed for configuration.

5. Resume normal procedures.

**NOTES**

1. Operators may, at their discretion, develop and use a normal takeoff procedure when community noise considerations are not a factor. The operator may not develop a normal procedure that prescribes a power or configuration change before attaining 800 feet AFE.

2. The standard noise abatement profiles do not apply when it could be construed to affect the responsibilities and authority of the pilot in command for the safe operation of the airplane under FAR 91.3 or other regulations.

3. Intermediate flap changes before the noise abatement initiating altitude are permitted when appropriate for climb performance.

4. Cutback thrust for airplanes with slow flap retraction rates may be set at an intermediate flap setting.

## ATTACHMENT 3

# Comparison of Noise Abatement Departure Procedures

## Noise Under the Flight Path

Figures 1 and 2 depict the results of an analysis comparing the estimated single event noise levels under the flight path for three commercial jet aircraft representing those with low bypass engines meeting Stage 2 noise limits, with low bypass and modifications to meet Stage 3, and with high bypass meeting Stage 3. The three departure procedures under evaluation are described as follows:

1. Max. Climb:
   - Takeoff power to 800 feet AGL
   - Cutback to maximum continuous climb power
   - Accelerate and retract flaps and slats
   - Maintain maximum continuous climb power
2. Cutback Clean:
   - Takeoff power to 800 feet AGL
   - Accelerate and retract flaps and slats
   - Cutback to thrust not less than that necessary to maintain the engine-inoperative climb gradient specified by FAR 25.111(c) (3)
   - At 3000 feet AGL, increase thrust to maximum continuous climb power
   - Maintain maximum continuous climb power
3. Cutback Dirty:
   - Takeoff power to 800 feet AGL
   - Cutback to thrust not less than that necessary to maintain the engine-inoperative climb gradient specified by FAR 25.111(c) (3)
   - Accelerate and retract flaps and slats
   - At 3000 feet AGL, increase thrust to maximum continuous climb power
   - Maintain maximum continuous climb power

Sound Exposure Level (SEL) is a physical measure of sound in decibels (dB) which accounts for both the magnitude of the event and its time pattern. This combination of magnitude and duration is called exposure. Lines of noise under the flight path, as shown in the figures, convey the relationships between noise observed on the ground and the position and performance of the aircraft. As aircraft altitude increases, observed noise levels decrease. The abrupt downward shift in the lines indicates the effect of engine thrust cutback during those portions of the departure profiles. Likewise, the upward shift indicates reapplication of thrust to maximum continuous climb power.

The graphs depict the relative merits of "close-in" and "distant" noise abatement departure procedures which are portrayed in this analysis by the "Cutback Dirty" and "Cutback Clean" profiles, respectively. As is apparent, the thrust reduction schedule is the key component in determining the location of the noise reduction. The immediate cutback at 800 feet AGL for the B727-200/JT8D-15QN provides a 4 dB reduction when compared to the "Max. Climb" procedure. While the "Cutback Clean" procedure generates levels 6 dB above the "Max. Climb" over the same area. Looking at this another way, the deep thrust cutback at 800 feet AGL produces noise levels close-in that are 4 dB lower than if the cutback is to maximum continuous climb power and 10 dB lower than if takeoff thrust is maintained. As a point of reference, attitudinal surveys have shown that individuals describe noise events that are 10 dB higher than other events as being twice as loud. At "distant" locations, the "Cutback Clean" procedure generates levels 5 dB below the "Max. Climb." The other two aircraft exhibit similar fluctuations in noise levels among the procedures but not nearly to the same extent as the Stage 2 B727. In addition, performance differences among aircraft and weight differences for the same aircraft make it difficult to target a single altitude for thrust reduction which would result in optimal noise reductions for all aircraft at the same distance from the runway.

The information presented so far is simply a quantitative comparison of the reduction in noise levels for aircraft flyovers without attempting to gauge the overall relief or benefit which could be expected. In FAR Part 150, FAA adopted Day Night Average Sound Level (DNL) for the following purposes:

a. establish a single system of noise measurement to be uniformly applied in measuring noise at airports and in surrounding areas for which there is a highly reliable relationship between projected noise and surveyed reaction of people to noise;

b. establish a single system for determining the exposure of individuals to noise which results from the operations of an airport; and

c. identify land uses which are normally compatible with various exposures of individuals to noise.

DNL is a measure of the cumulative noise exposure from all aircraft flyovers during a typical 24-hour period. The basic formula for DNL yields the postulate that DNL increases 3 dB for every doubling of aircraft operations. Applying the DNL concept to an evaluation of the benefit of noise abatement procedures reveals that a 4 dB reduction on every aircraft flyover has the same effect on the cumulative noise exposure received by the community as reducing the number of overflights by 60%. Because DNL is a model of the total sound energy, the noisier events such as Stage 2 B727 flyovers will tend to dominate the level of cumulative exposure over the contribution of B757 or other Stage 3 aircraft operations.

Comparison of Noise Abatement Departure Procedures: Noise Under the Flight Path

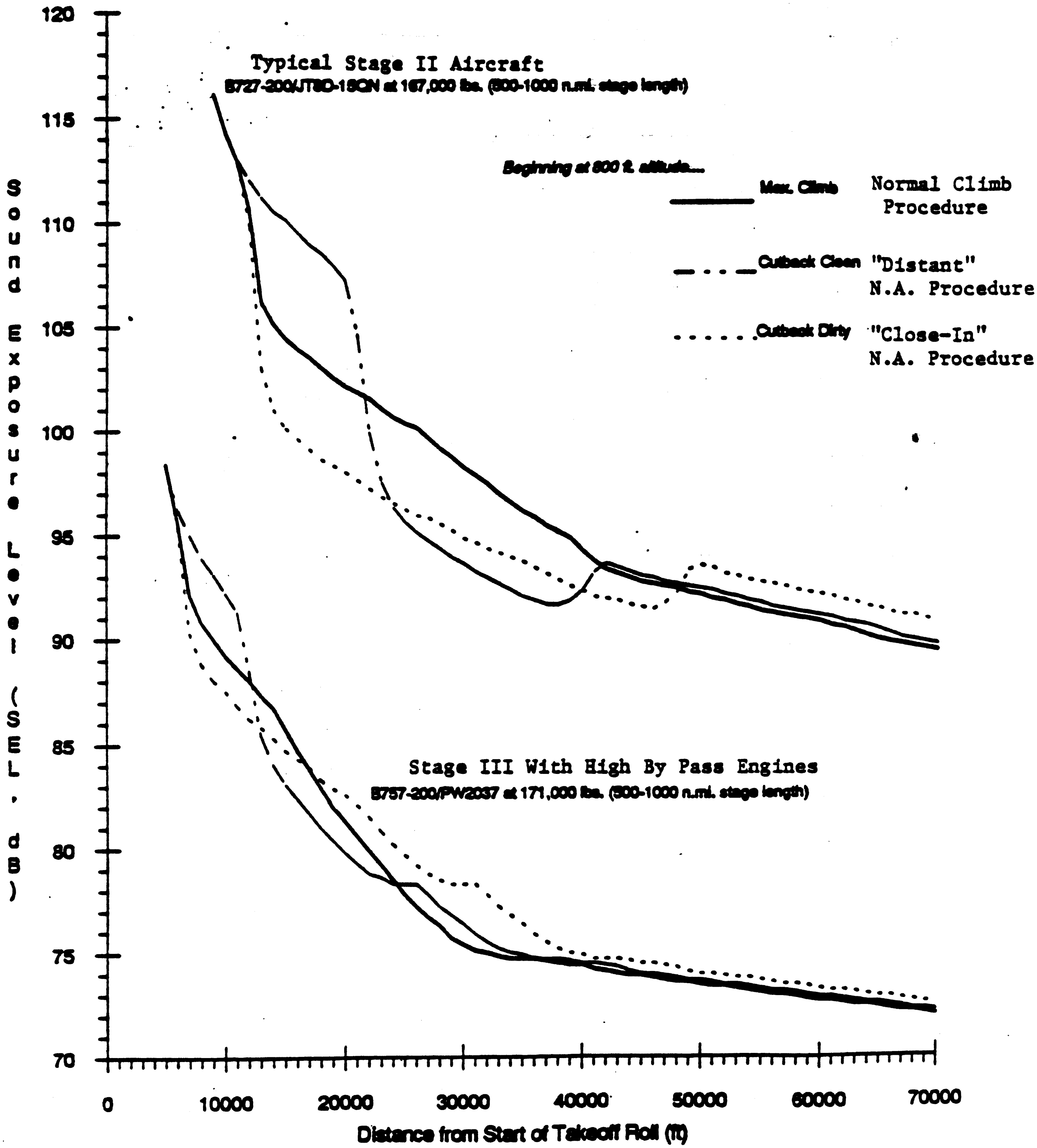


FIGURE 1

ATCA 3-

**Comparison of Noise Abatement Departure Procedures: Noise Under the Flight Path**

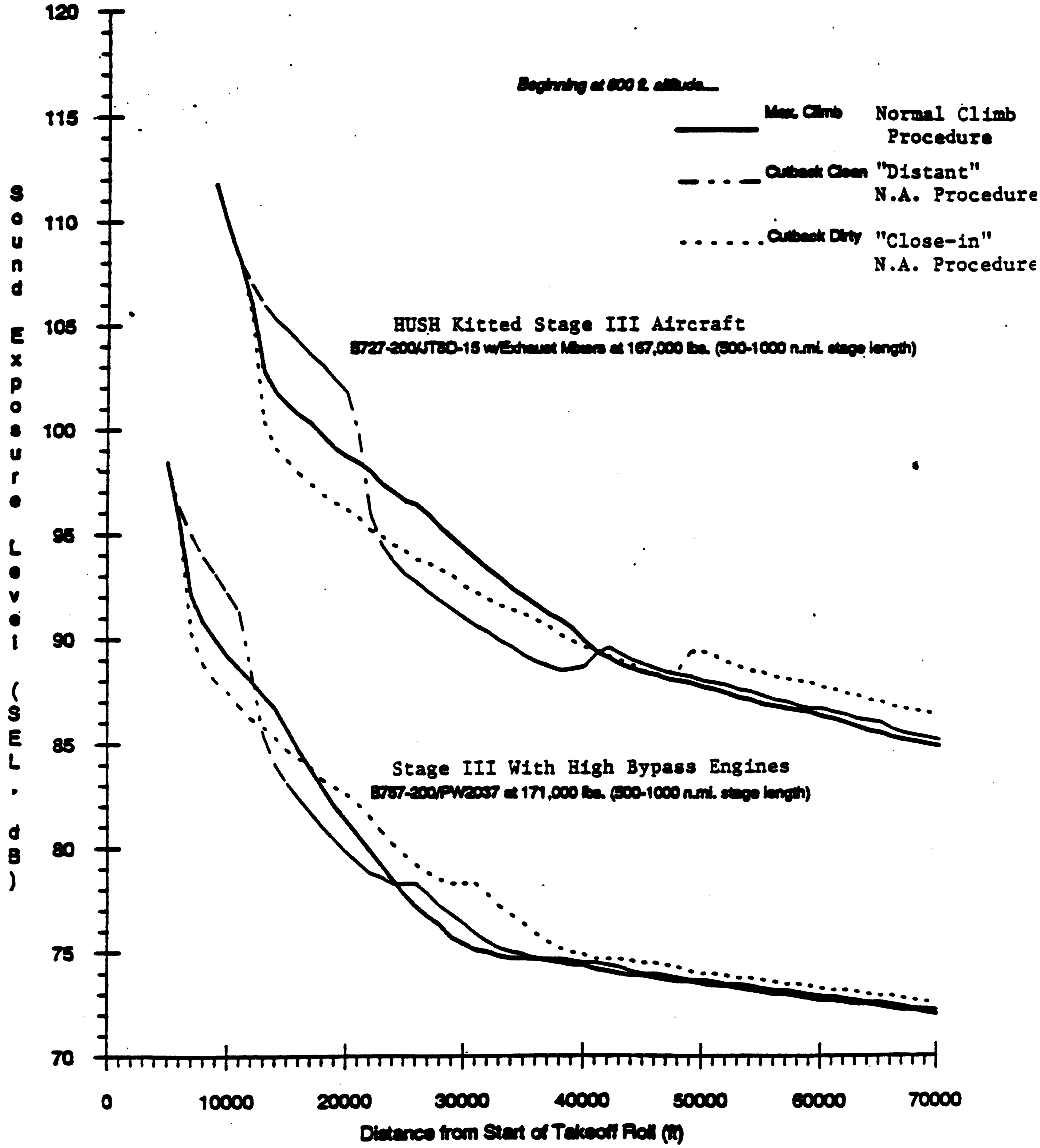


FIGURE 2

ATCH 3-4

With High Bypass Engines

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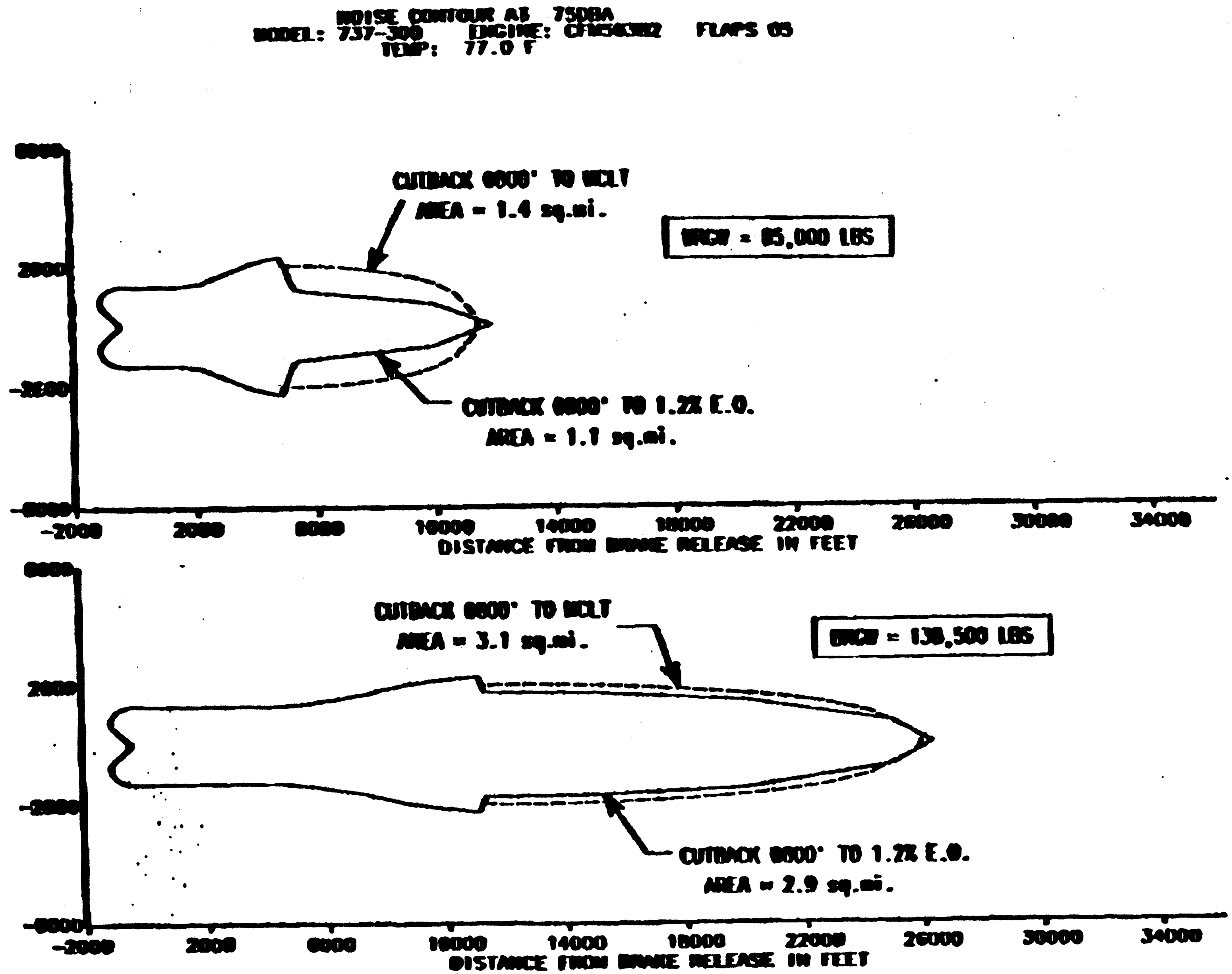
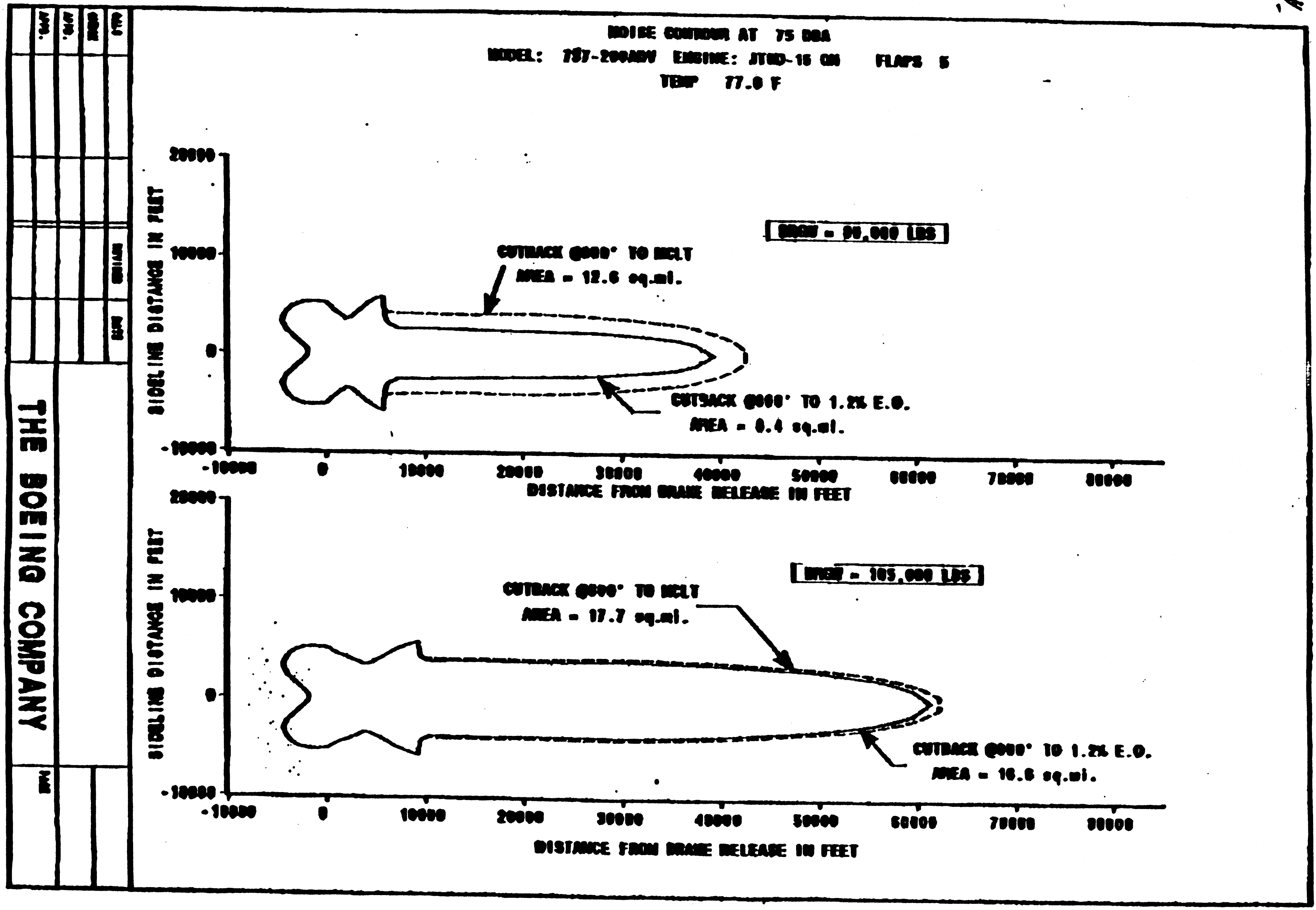


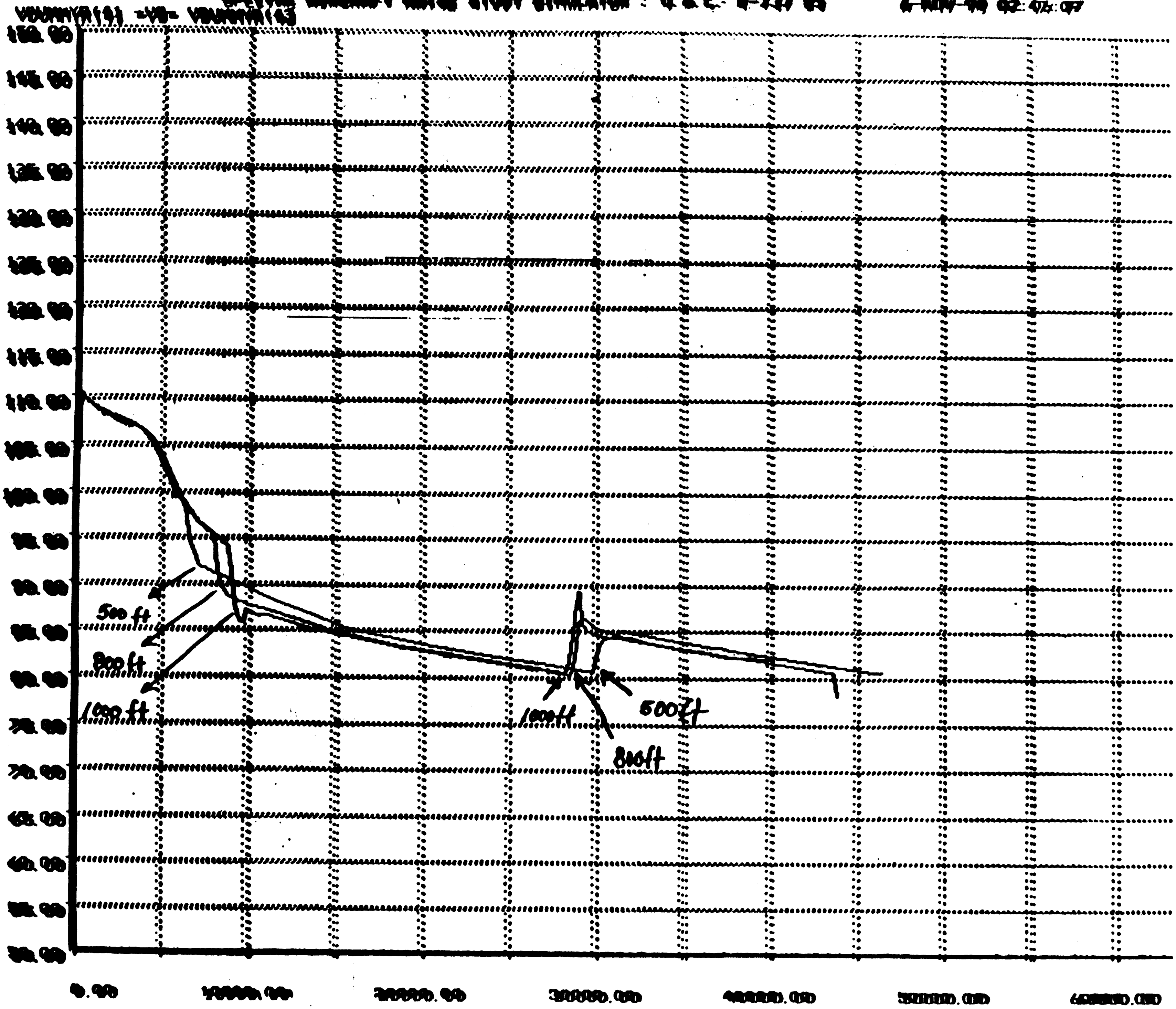

THE BOEING COMPANY

ATC#3

STAGE II AIRCRAFT



SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U & C B-737




ATC#3-7

**MCDONNELL DOUGLAS**

*Douglas Aircraft Company*

*THOMAS M. RYAN, JR.*
*Vice President*
*KC-10, Flight Operations,*
*Training, and Customer Support*

July 25, 1990
C1-AF1-TMR-069

Mr. Charles W. Euler, AFS-4C1
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Dear Mr. Euler:

Douglas Aircraft Company (DAC) has reviewed the draft of FAA/Joint Industry Noise Abatement discussion paper which was distributed during the June 19, 1990, meeting. We wish to offer the following comments:

1. We agree on the concept of three standard takeoff procedures:

   - Normal Takeoff
   - Standard close-in takeoff noise abatement procedures
   - Standard far-out takeoff noise abatement procedures

   However, we do have some concerns on the specific requirements of the latter two.

2. Some MD-80 operators presently have FAA approved takeoff noise abatement procedures using manual throttle cutbacks. Since these procedures are approved, safe and presently utilized, Douglas has no problem with them. We cannot support future regulations that would infringe upon these presently approved procedures.

3. Specifically, DAC does not agree with paragraph d. (2) and (3) of page 3, where it is mandated that thrust cutbacks below 1,000 feet to gradients less than FAR 25.111 (c) (3) must have automatic cutback systems with automatic thrust advance systems and Ground Proximity Warning System (GPWS) capable of alerting the flight crew of any descent below 1,500 feet AGL.

   (a) Manual cutbacks to 1.2% single engine climb gradient have been approved to altitudes as low as 500 feet AGL without auto thrust advance systems or GPWS. These approvals should not be negated by future regulations.

(b) To our knowledge, no presently certified GPWS provides the specific requirements as written. All GPWS's permit some altitude loss following takeoff, before providing a warning. It is our opinion that a more general requirement be stipulated that would provide the intent of altitude warning, not specifically require a revision to presently approved GPWS's.

4. DAC also does not agree with paragraph 5b., page 1-2, of Attachment 1, wherein it is specified that a single flight/crew action must be initiated for thrust cutback. This wording, in its most strict interpretation, would exclude fully automatic takeoff thrust cutback systems that may be proposed in the future. Certainly today's and/or tomorrow's technologies will produce fully automatic systems that provide high levels of safety and performance. These advancements should not be curtailed by these proposed noise abatement procedures.

5. In summary, DAC supports legislation that standardizes thrust cutback procedures, and firmly believes future systems can be fully automatic and safe as well as reliable. These systems should be able to provide a thrust cutback capability for 0% engine-out climb gradient.

DAC does not support legislation that negates presently approved procedures that have been proven to be safe.

In order to assure that a unified national noise policy is established, we recommend this proposed rule making on noise abatement be developed and integrated with the efforts presently being formulated by the Aviation System Capacity Task Force Noise Working Group.

Yours very truly,

T. M. Ryan Jr.
Vice President
KC-10, Flight Operations,
Training and Customer Support

FWH:mlb

MCDONNELL DOUGLAS

Douglas Aircraft Company

9 August 1990

Mr. Charles W. Euler, AFS-4C1
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20541

FAX: (202) 267-5230

Enclosures: (a) DC-9 Super 80 FCOM, Section 4; 3 pages
(b) MD-11 GPWS Warning Envelopes, page 34-45-0; 1 page

References: (1) Telecon between You and Frank Anderson on 20 July 1990
(2) DAC Letter, from T. J. Ryan dated July 25, 1990

Dear Mr. Euler:

During the Reference (1) telecon, Frank Anderson offered to send information on presently certified Ground Proximity Warning Systems (GPWS), specifically warnings during takeoff. Frank stated that presently certified GPWS' provide flight crew warnings following some small amount of altitude loss during takeoff. But, to the best of our knowledge, no certified system provides warning for all altitude losses, however small. Paragraph 3(b) of Ref. (2) substantiated Frank's comment.

To provide additional information on this subject, enclosures (a) and (b) respectively depict the functional capabilities of the ARINC 594 MARK II GPWS installed in the MD-80/90, and the ARINC 723 MARK V GPWS installed in the MD-11.

Both the MARK II and MARK V systems provide several ARINC defined modes of operation including Mode 3, ALTITUDE LOSS AFTER TAKEOFF. Mode 3 will be the mode of interest during takeoff noise abatement thrust cutbacks.

GPWS Mode 3 provides a warning during takeoff in event of barometric altitude loss exceeding approximately 10% of the radio altitude where the initial descent began. Mode 3 is inhibited above 700 ft. AGL in the MARK II system and inhibited above 2500 ft. AGL in the MARK V system.

For further information, please contact Frank or myself.

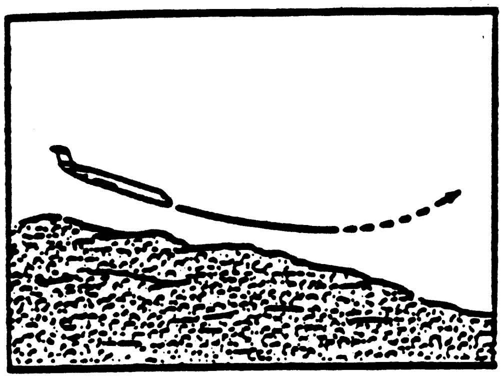
Sincerely,

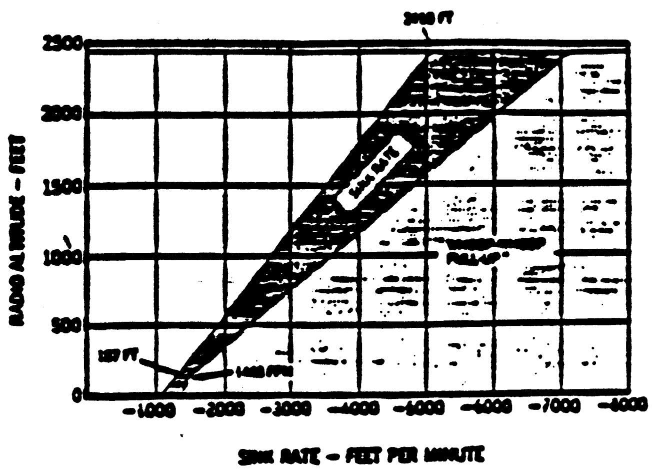
J. D. Taylor

J. D. Taylor
Business Unit Manager
MD-80/90 Avionics Engineering
(213) 593-2050

# INSTRUMENTATION AND NAVIGATION - Ground Proximity Warning System Warning Annunciation

## MODE 1 – EXCESSIVE DESCENT RATE

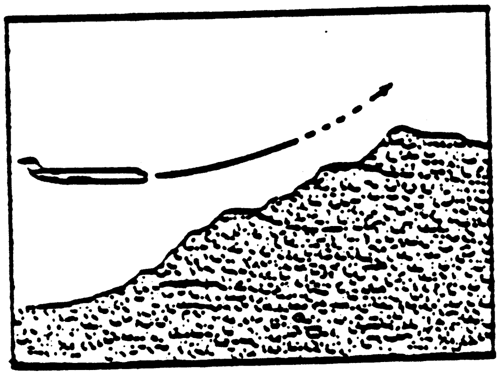




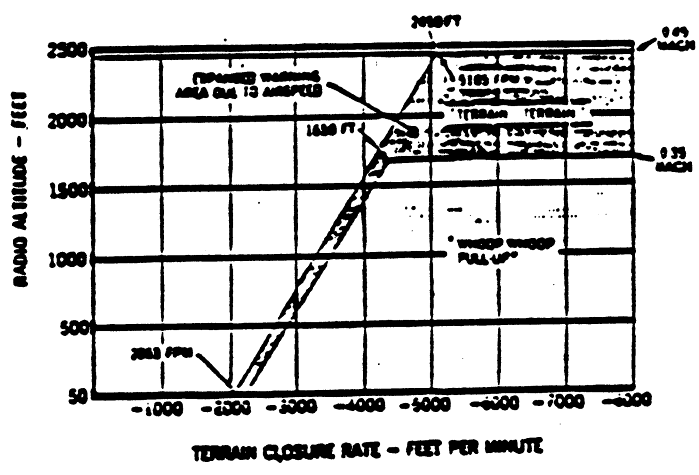

VISUAL INDICATION – GPWS light on.
AURAL/VOCAL ANNUNCIATION –
"SINK RATE, SINK RATE" (Repeated every 0.75 seconds.)
"WHOOP WHOOP-PULL UP" (Continuous)

This mode indicates rate of descent for given altitude excessive and condition should be corrected. Any excessive sink rate (barometric altitude) below 2450 feet radio altitude actuates aural/vocal annunciation. Mode is independent of aircraft configuration and is functional to within 50 feet terrain.

## MODE 2 – EXCESSIVE TERRAIN CLOSURE RATE



AIRCRAFT NOT IN LANDING CONFIGURATION




VISUAL INDICATION – GPWS light on.
AURAL/VOCAL ANNUNCIATION –
"TERRAIN-TERRAIN" (Rapid succession.)
"WHOOP WHOOP-PULL UP" (Repeated every 0.75 seconds)

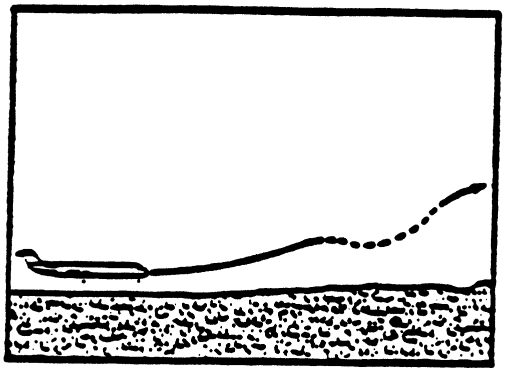
"TERRAIN-TERRAIN" will be activated first. If rate of descent continues or increases, "WHOOP WHOOP-PULL UP" will be activated.

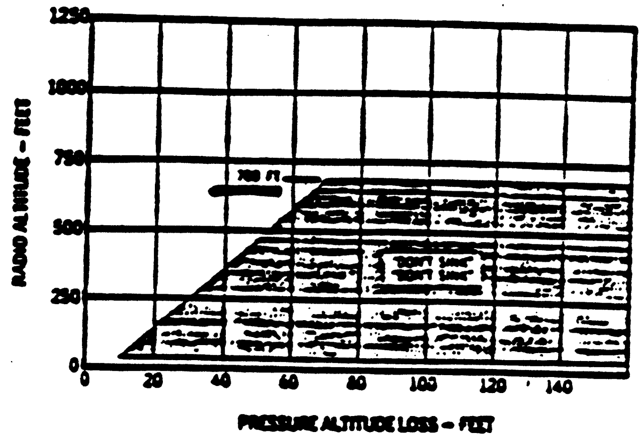
After closure continuation ceases, and "PULL UP" annunciation has stopped, a barometric altitude gain of 300 feet is required before the "TERRAIN" annunciation (repeated in 0.75 second cycle) is shutoff. During an approach, when gear or flaps are extended, the altitude gain function is inhibited and the "PULL UP" annunciation is replaced by "TERRAIN".

RA1-1772

# INSTRUMENTATION AND NAVIGATION - Ground Proximity Warning System
## Warning Annunciation

**MODE 3 – Altitude Loss After Takeoff**





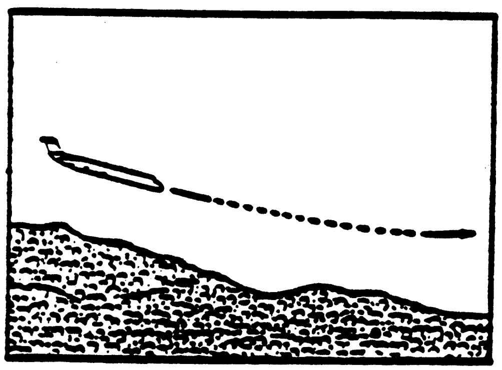

VISUAL INDICATION – GPWS light on.
AURAL/VOCAL ANNUNCIATION –

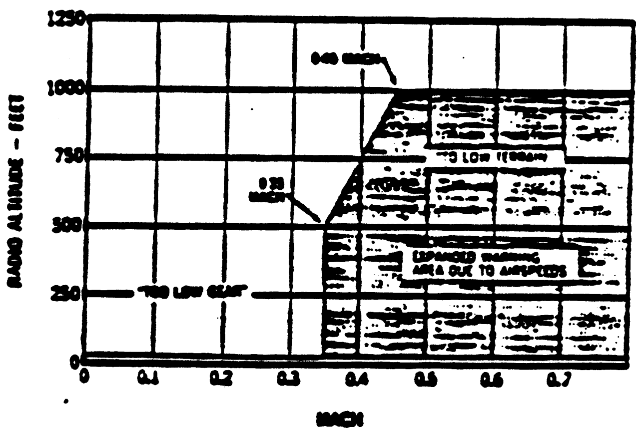
"DON'T SINK, DON'T SINK"

(Repeated in 0.75 second interval cycle until positive rate of climb is established.)

"DON'T SINK" message repeats until positive rate of climb established. At that point, the warning stops but GPWS computer continues to compare aircraft barometric altitude to the altitude of initial descent. If aircraft should descend again before climbing to initial altitude, another warning will be generated, based on original altitude. The warning threshold is when 10% (approx.) of the initial descent altitude has been lost. This mode is active from 65 feet to 700 feet AGL during takeoff or when either flaps or gear is raised during a missed approach from below 200 feet AGL. Above 700 feet, the GPWS computer automatically switches to TERRAIN CLEARANCE Mode.

**MODE 4A – TERRAIN CLEARANCE (Descent in Wrong Configuration – Gear Up)**






VISUAL INDICATION – GPWS light on.
AURAL/VOCAL ANNUNCIATION –

"TOO LOW GEAR" (Repeated in 0.75 second interval cycle.)
"TOO LOW TERRAIN" (Repeated in 0.75 second interval cycle.)

This mode is activated upon clearing 700 feet AGL after takeoff. Below 0.35 Mach, "TOO LOW GEAR" is announced. Above 0.35 Mach, "TOO LOW TERRAIN" is announced. Warning is inhibited below 50 feet.

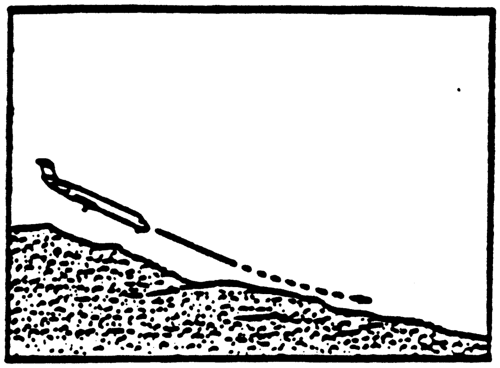
RA1-1773

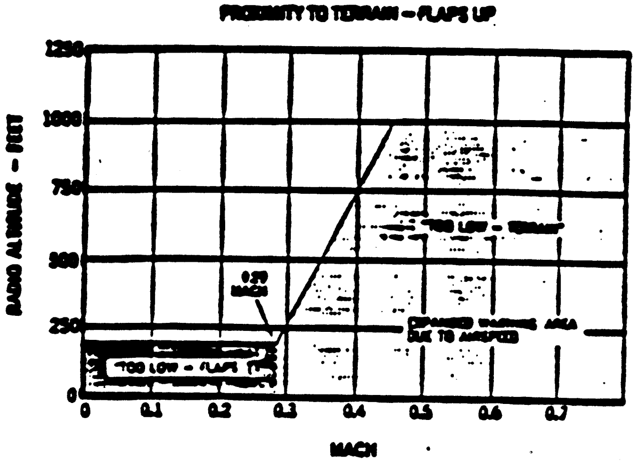


ATCH 4-5

# INSTRUMENTATION AND NAVIGATION - Ground Proximity Warning System Warning Annunciation

MODE 4B – TERRAIN CLEARANCE (Descent in Wrong Configuration-Gear Down, Flaps Not in Landing Position)



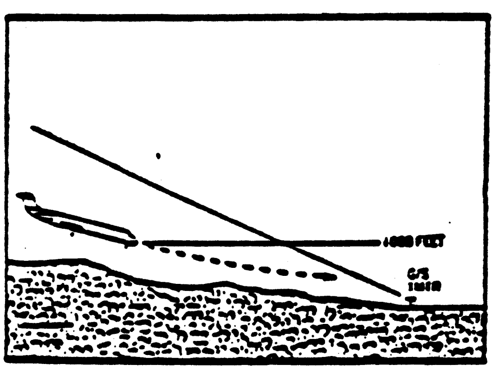


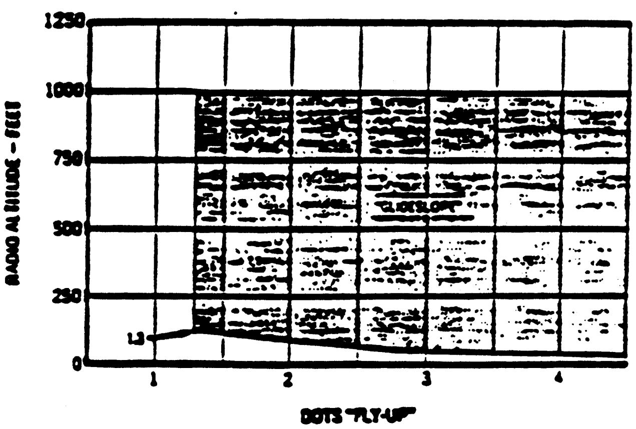

VISUAL INDICATION – GPWS light on.
AURAL/VOCAL ANNUNCIATION –
"TOO LOW FLAP" (Repeated at 0.75 second interval cycle.)
"TOO LOW TERRAIN" (Repeated at 0.75 second interval cycle.)

This Mode is activated upon clearing 700 feet AGL after takeoff. Below 0.29 Mach, with the flaps not extended for landing, "TOO LOW FLAPS" is announced.

Above 0.29 Mach, "TOO LOW TERRAIN" is announced. If gear is extended and then retracted, "TOO LOW GEAR" will be announced at 200 feet AGL if still retracted. Warning is inhibited below 50 feet and reverts to Mode 3 (with both gear and flaps down).

MODE 5 – DESCENT BELOW GLIDESLOPE




VISUAL INDICATION – BELOW G/S light on.
AURAL/VISUAL ANNUNCIATION – "GLIDESLOPE".

This mode warns of excessive low ILS glide slope deviation when the aircraft is below 1000 feet radio altitude and a valid ILS frequency is received. When the glideslope advisory region is penetrated, a soft warning is given by illumination of the BELOW G/S light and voice annunciation "GLIDESLOPE". As the altitude is decreased and the DOTS "FLY-UP" glideslope deviation is increased, the glideslope voice warning audio output level and repeat rate will increase.

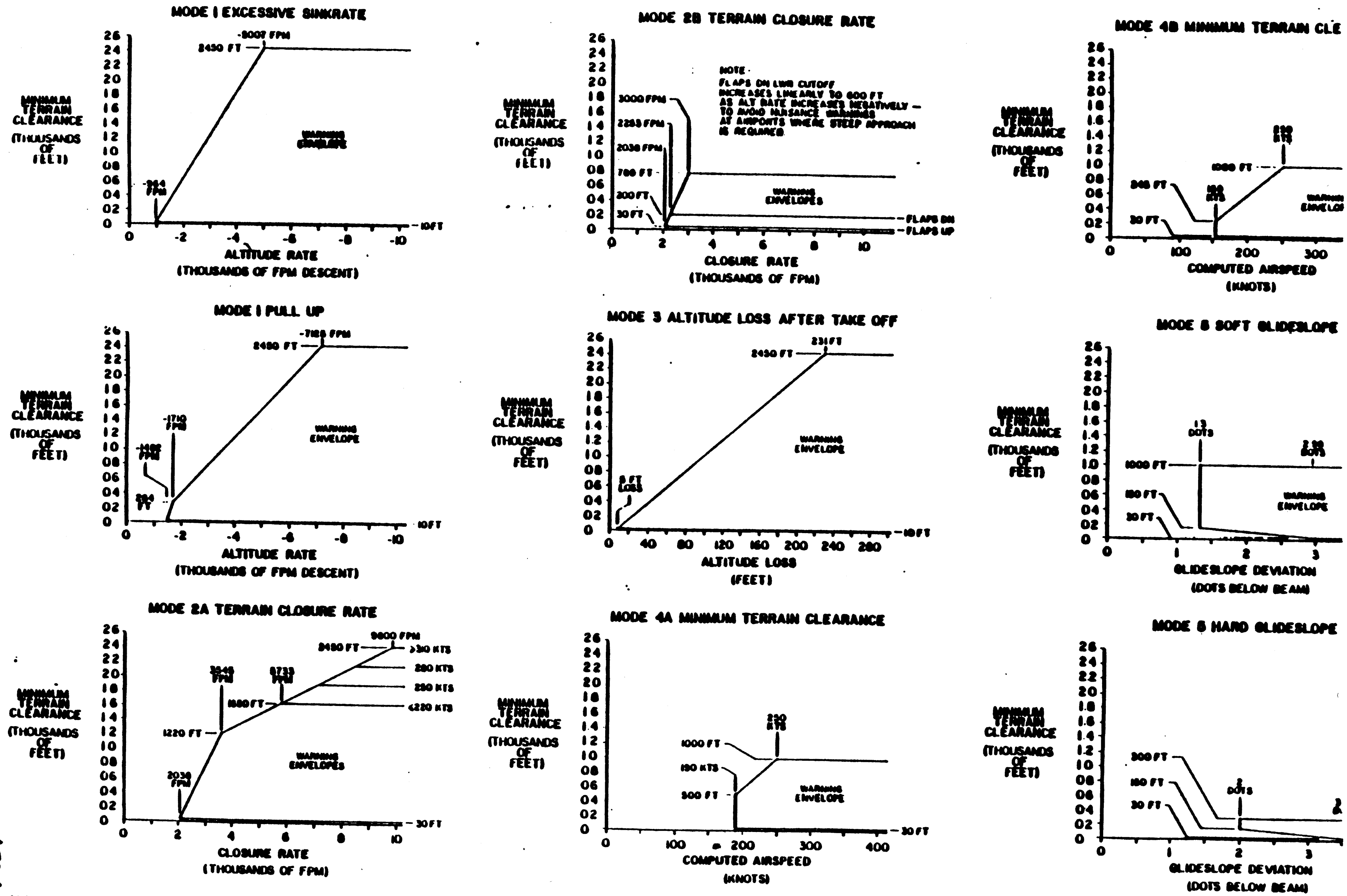
RA1-1774



ATC#4-

PRELIMINARY

SYSTEM SCHEMATIC




ATB 4-7

ALL CUSTOMERS

APPROVAL & CHANGE RECORD

34-45-0
SHEET 2 OF 2
CODE 100

GPWS
WARNING ENVELOPES

DOUGLAS | 88277 | MD-11 | 34-45 SHEET 2

Fokker comments on Joint FAA/Industry noise abatement discussion paper.

Page 1.

2b:

As the airspeed can increase above V2+20 if the airplane is limited by body angle we propose to change 2b in:

After takeoff climb at an airspeed of V2 + 10 to 20 knots or as limited by body angle whichever comes first until ......

2c and 2d:

In several FAA approved normal takeoff procedures first climb thrust is selected before flap retraction.
In Europe the IATA procedure is often used (climb thrust at 1500 ft and flap retraction at 3000 ft). We propose to leave open the sequence of climb thrust selection and selection of flaps.

Attachment 1-1:

3 Reduced thrust takeoffs.

We think it is not useful to carry out a reduce thrust takeoff in combination with a noise abatement procedure but why should it be prohibited?

4c. Definition of alert eye position should be given.
5" forward of reference eye position?

Attachment 1-2

4e How many times should the mean deviation be determined in order to find a reliable statistical value? Is 5 seconds the right time limit?

5d3 and 5e3:

It must be shown to be improbable that the automatic thrust advance feature has unacceptable failure modes.
This cannot be determined by an operational test or an evaluation. It should be done by failure analysis.
We propose a separate paragraph with airworthiness requirements as: performance, handling qualities, failure analyses etc. for certification and a paragraph dealing with operational tests and evaluations for approval of the procedure. In that case it is also clear for the manufacturer and/or operator whether FAA Flight Standards or FAA Airwirthiness has to be approached.

Attachment 1-3. 6a and 6b.
Attachment 1-4. 7b4.

In above mentioned sections the speedloss is restricted to (V2+x)-5 and to (V2+x)-2 not to exceed 10 seconds. It is Fokkers opinion that for take off the real minimum takeoff speed is V2 (Indicated on EFIS by amber band).

After and during thrust reduction a small speed drop is acceptable especially if the speed trend is small. A relevant requirement is that any speedloss must not exceed (V2+x)-5. A requirement for a speed loss of (V2+x)-2 not to exceed 10 seconds is superfluous.

In case of an engine failure the only requirement should be that speed loss must not exceed V2.
Minimum speed after an engine failure is V2.

Attachment 1-3. 6d.

Fokker does not agree that the pilot flying should be able to perform the thrust cutback procedure without assistance of the other pilot.
A noise abatement procedure must be developed for minimum workload by crew coordination.

Attachment 1-4.

Notes: This note gives the impression that it is allowed to engage the autopilot below 500 ft. Hopefully this will be approved.
If the autopilot meets all the requirements to be engaged after lift off, it should be recommended to do so after lift off.

Standard alternatives, speed requirements.

If the airplane has a low weight and is body angle limited, the speed can increase above V2+20. This is of course safe. Therefore there should be no limitation on speeds above V2+20.

General remarks.

It was noticed that both thrust and power is used in the paper. We use thrust for turbojet airplanes and power for propeller airplanes.
We propose to use only thrust.

Several times takeoff path engine inoperative climb is used in the paper. Should it not be takeoff path one engine inoperative climb.

ATCH 4

P.O. Box 3707
Seattle, WA 98124-2207

July 16, 1990
B-V20B-1048

Wes Euler, FAA
AFS 400
800 Independence Avenue S.W.
Washington, D.C. 20591

BOEING

Dear Wes,

Enclosed is the Boeing response to your "Joint FAA/Industry Noise Abatement Paper." The format of this response modifies the wording of the paper and marks areas of change by a bar notation in the right margins. Explanations are provided in italicized letters where it was deemed necessary to convey our reasons for the change. Other changes were assumed self-explanatory.

An additional option exists rather than making an extensive change to AC91-53 and is described here in concept with the details to be worked out. The additional option contains two primary elements: 1) Cutbacks below 1000 feet AGL and/or below FAR 25.111(c)(3) engine inoperative gradients would not be allowed, and 2) airport noise rules based on noise monitors closer than the distance necessary for airplanes to become stabilized at cutback power after reaching 1000 feet AGL would not be allowed. This additional option would have the benefits of enhanced safety, quieter environment for the majority of the communities and greater standardization of takeoff procedures. It should be emphasized that element number 2 (above is an essential ingredient to the viability of this option.

Please call me at telephone number 206-655-3041 or Dick Potter, 206-234-5729, if you would like to discuss these matters.

Sincerely,

M E Hewett

M. E. Hewett
Engineering Test Pilot

ATC#4- 10

# JOINT FAA/INDUSTRY NOISE ABATEMENT PAPER

## JUNE 19, 1990

Proposed Resolution: The following proposal is offered for the purpose of initiating discussion and to serve as a basis for exploring alternative approaches and should not be construed as an FAA recommendation or position.

1. Develop and publish a revision to Advisory Circular (AC) 91-53 to establish a set of standard noise abatement procedures from which an operator can select one or two of the procedures as the standard for a particular airplane type. The (AC) would specify that an operator could select a procedure or a combination of procedures which is or are optimal for that airplane type. The operator would then train flightcrews who operate that airplane type to use only the selected procedure or combination of procedures. Once the standard procedure or procedures were adopted by an operator, they would be used, as appropriate, for all airport/community environments. For the purpose of standardization, efficiency of training, noise abatement and airport/community planning up to three standard takeoff procedures for each airplane type could be used. The three standard takeoff procedures for the purpose of this discussion are referred to as follows:

- Normal takeoff procedure
- Standard close-in takeoff noise abatement procedure
- Standard far-out takeoff noise abatement procedure

2. Normal Takeoff Procedure: The normal takeoff procedure may be developed by the manufacturer and adopted by the operator or it may be a procedure developed by the operator. The normal takeoff procedure would be used on runways where noise abatement is not a factor or on runways where the standard noise abatement procedures do not provide any significant or the desired noise relief. The normal takeoff procedure would be reviewed and approved at the local FAA District Office level provided it is consistent with the criteria listed below:

a) Set takeoff thrust as specified by the operator (either maximum takeoff thrust or an appropriate reduced takeoff thrust setting).

b) After takeoff, climb at an airspeed $V_2 + X$ knots until attaining an altitude specified by the operator (either a standard altitude or an obstacle clearance altitude) but not lower than 400 feet. I

c) At the altitude specified by the operator, decrease pitch and accelerate to $V_{2f}$ while retracting flaps on schedule (if flaps are not used for takeoff, decrease pitch and accelerate to climb speed).

d) After attain $V_{2f}$ or at a point specified by the operator, set climb thrust and initiate a climb profile as specified by the operator.

3. <u>Standard Noise Abatement Procedures:</u> Perceived takeoff noise depends on the airplane/engine combination, takeoff configuration, performance characteristics, and the takeoff initial climb procedure used as well as the environmental (noise sensitive) characteristics of the airport. An operator may determine that for a particular airplane type the normal takeoff procedure provides the best overall relief at noise sensitive airports (including both close-in and far-out noise sensitive areas). For another airplane type, an operator may determine that a single noise abatement procedure is appropriate for both close-in and far-out noise sensitive areas and as a result the operator would adopt and use both a normal takeoff procedure and a single standard takeoff noise abatement procedure. However, for many airplanes in operation today, there is an optimal takeoff procedure which provides the most relief for close-in noise sensitive areas and another takeoff procedure which provides the most relief for noise sensitive areas that are further out from the runway. As a result, an operator may determine that three takeoff procedures need to be adopted for the type of airplane operated and the environmental characteristics of the airports served. An operator would not be authorized to use more than three standard takeoff procedures ( a normal, close-in, and a far-out takeoff procedure).

a. Noise abatement procedures are either developed by the manufacturer and adopted by the operator or they are developed by the operator. There are two general categories of noise abatement procedures.

1) One category provides relief to noise sensitive areas that are "close-in" to the end of the takeoff runway. The procedures in this category generally involve climbing in the takeoff configuration to a specified altitude and then simultaneously decreasing pitch and setting a predetermined cutback thrust and either overflying the noise sensitive area before accelerating, retracting flaps, and setting climb power, or accelerating and retracting flaps while overflying the noise sensitive area, before setting climb power.

2) The other category provides relief to noise sensitive areas that are "far-out" from the end of the takeoff runway. The procedures in this category generally involve climbing in the takeoff configuration to a specified altitude and then decreasing pitch to accelerate while retracting flaps and after the flaps are retracted (or partially retracted) setting a predetermined cutback thrust and overflying the noise sensitive area before setting climb power.

b. The optimum type of procedure for either a close-in or far-out noise sensitive area is highly dependent on the airplane's takeoff configuration and performance characteristics as well as the takeoff weight. If it is determined that both close-in and far-out noise abatement procedures are needed for a particular airplane type, an operator would be able to select two standard noise abatement procedures and train flightcrews in their use. The operator, in this case, would have to instruct flightcrews on which procedure to use for particular runway/noise sensitive area environment.



ATCH 4 -

c. Obstacle clearance requirements must be considered when selecting an altitude at which either a flap configuration change is initiated or at which a thrust cutback is initiated for noise abatement purposes. Obstacle clearance altitudes are a variable altitude depending on the airport and surrounding terrain or obstacles. The amount of noise relief provided by a standard noise abatement procedure at a particular runway/noise sensitive area environment is also dependent on the altitude at which either the flap configuration change is initiated (with subsequent thrust cutback) or at which the thrust cutback is initiated in the takeoff configuration. By adjusting this initiating altitude, noise relief can be optimized for a particular runway/noise sensitive area environment. The initiating altitude would be the only variable permitted for particular standard noise abatement procedure. The operator would have to specify the initiating altitude for a particular runway/noise sensitive area environment.

d. When the initiating altitude is established at the lower altitudes, the available airspace in which to maneuver is decreased. In addition, decreased thrust levels, decreases performance margins. Therefore, in order to ensure adequate safety, specific criteria would have to be met before approving the use of an initiating altitude below 1,000 feet and/or approving the use of a cutback thrust setting lower than that necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3) (assuming an engine failure without any thrust advance on the remaining engine(s)). The general criteria that would have to be met for each procedure and airplane type are as follows:

(1) The procedure would have to operationally evaluated and tested by the FAA for the airplane type. The factors and specific criteria that would be considered by the FAA are outlined in Attachment 1. The Director, Flight Standards Service (AFS-1) would be responsible for reviewing the results of the tests and if satisfactory approving the procedure for the particular airplane type. Once a specific procedure for an airplane type has been approved by AFS-1, it could then be approved for specific operators.

(2) Any procedure which specifies a cutback thrust of less then that necessary to maintain FAR 25.111C(3) gradients would have to incorporate an automatic thrust recovery system. In no case shall the thrust be cut back to less than 0% all engines. I

***Explanation:***

*The requirement for a thrust recovery system should be a function only of the magnitude of the thrust cutback.*

*FAR 25.111c(3) specifies an engine out gradient starting at 400 ft. that provides an obstacle clearance path. (See Fig. (1)). Any close-in noise abatement takeoff with a cutback initiated above 400 ft. and the appropriate thrust restoration method can*

FAR 25.111C(3)
ENGINE OUT PERFORMANCE

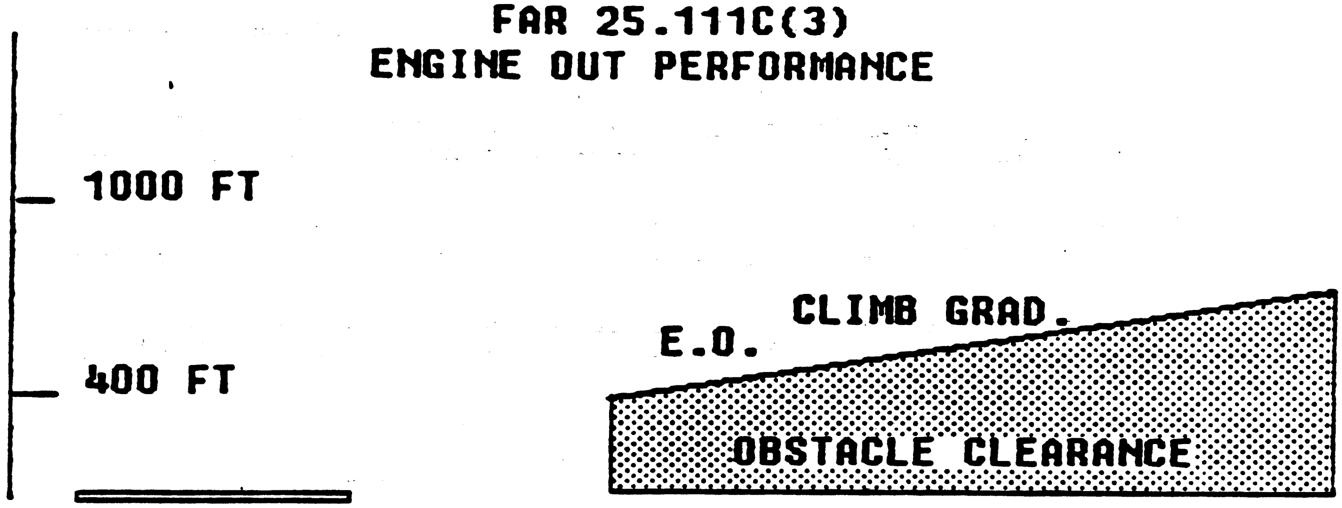



FIG.1

CLOSE IN PROCEDURE

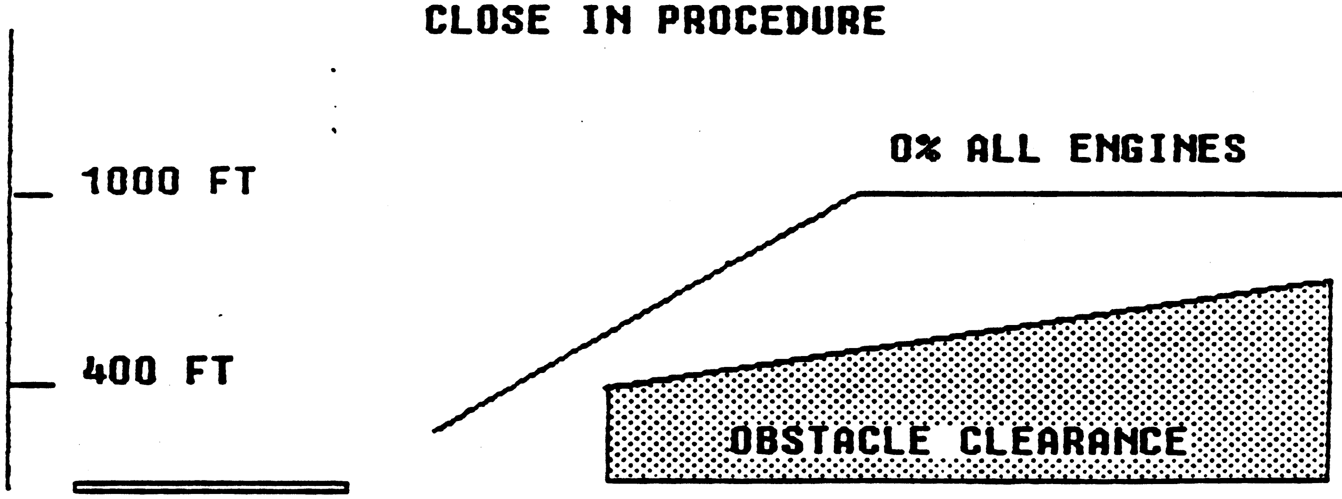



FIG. 2



ATBH 4-14

*maintain the aircraft at or above the FAR 25.111C(3) obstacle clearance path. (See Fig. (2)).*

(3) Any procedure which specifies any cutback less than 1000 ft. AGL would have to incorporate an automatic thrust cutback feature. I

*Explanation:*

*The requirement for an automatic thrust reduction system should only be a function of the cutback altitude. The cutback system is designed to reduce both pilots workload while in close proximity to the ground. An altitude of 1000 ft. is a typically accepted safe altitude for pilot manual actions such as manually setting climb thrust and moving flap levers.*

(4) All procedures which specify a cutback altitude below 1500 ft. AGL shall require a GPWS alerting system. I

*Explanation:*

*A requirement to provide crew alerting for unacceptable altitude losses during the noise abatement maneuver stands alone. Altitude loss can occur for reasons not associated with the magnitude of the thrust cutback ie. pilot distraction, disorientation, etc.*

e. In the interest of keeping the standard noise abatement procedures to a minimum, operators would be able to request that the procedures outlined in Attachment 2 (close-in) and Attachment 3 (far-out) be approved for their operations. The procedures presented in Attachment 2 and 3 are examples only and are offered for the purpose of generating discussion and more in-depth examinations. The approval level would be indicated for each procedure. An operator may request approval of a procedure different than the ones outline in Attachments 2 and 3 by submitting a request through the assigned POI to AFS-1 for appropriate processing.

ATTACHMENT 1

OPERATIONAL TEST AND EVALUATION

CONSIDERATIONS

ATC#4-16

~~ATTACHMENT 1~~

## OPERATIONAL TEST AND EVALUATION

## CONSIDERATIONS

1. Definition of Minimum Cutback Thrust: Cutback thrust means a thrust setting that in the event of an engine failure is not less than the setting necessary to maintain the takeoff path engine-inoperative climb gradients specified for a particular alternative noise abatement procedure. These thrust sets are determined without considering the subsequent addition of thrust on the remaining engine(s) from a pilot action or an automatic thrust advance system. Thrust cutback means the act of setting cutback thrust.

2. Minimum Thrust Cutback Altitude: The setting of the cutback thrust for noise abatement purposes shall not be initiated below 400 feet AGL.

3. Reduced Thrust Takeoffs: Takeoffs using reduced thrust for the purposeof reducing engine maintenance cost should be prohibited if it causes the use of an alternative noise abatement procedure.

4. Flight Path (Pitch Angle) Change Considerations: If a proposed procedure requires an initial pitch attitude that is greater than the normal operational pitch limit specified in the manufacturers flightcrew operating manual, an operational test and evaluation shall be required to determine whether special training and/or currency or other provisions are required. Factors that should be considered in determining whether special training or currency should be required include the following:

   a. The rotation rates required to achieve the target pitch attitudes. The required rotation rates cannot exceed the values established by the manufacturer for normal flight operations.

   b. Difficulty of speed control when transitioning from full power to cutback thrust during all engine operation and operations where an engine failure occurs during the transition.

   c. The pilots visibility at the reference eye position and the alert eye position.

5. Thrust Setability Considerations:

   a. The target cutback thrust setting should be determined (calculated) before takeoff. If an automatic thrust cutback feature is used, a minimum acceptable thrust cutback setting should be available so that the flightcrew can monitor the performance of the automatic thrust cutback feature.

b. The thrust cutback must be armed or initiated by a single flightcrew action when the aircraft is at or above 400 ft. (For example: manual throttle reduction or activation of a switch which initiates or arms an automatic thrust cutback feature.)

c. If thrust cutback is accomplished by manual throttle reduction below a height of 1,500 feet, operational tests and evaluation must be conducted to determine whether a pilot of average skill can quickly, accurately, and reliably set the target cutback thrust without undue attention. During these tests, the absolute value of the mean deviation from the target setting shall be determined. This mean deviation shall thereafter be added to the target thrust settings to establish the minimum settings that can be used in actual operations.

d. If thrust cutback is accomplished by automatic devices, an operational test and evaluation shall be required to determine the following:

1) The flightcrew must be able to adequately monitor the performance of the automatic devices and such monitoring must not require an inordinate amount of flightcrew attention;

2) The thrust cutback must be smoothly, accurately, and reliably set;

3) It must be shown to be improbable that the automatic thrust cutback feature has unacceptable failure modes;

4) Any detected failure of the automatic thrust cutback system is adequately annunciated or otherwise clearly apparent to the flight crew;

5) The automatic thrust cutback feature must be inhibited below 400 feet AGL or a higher specified height; and

6) It must be shown to be extremely improbable that an automatic thrust cutback failure could occur which could result in a thrust cutback below 400 feet AGL.

e. If an automatic thrust advance system is used, an operational test and evaluation shall be required to determine the following:

1) The thrust advance is immediate and provides, without flight crew intervention sufficient thrust to maintain at least the FAR 25.111 engine gradients.

2) The required thrust advance setting is quickly, accurately, and reliably set.

3) It must be shown to be improbable that the automatic thrust advance feature has unacceptable failure modes.

4) That any detected failure of the automatic thrust advance system is adequately annunciated or otherwise clearly apparent to the flightcrew.

6. <u>Aircraft Controllability Considerations:</u> An operational test and evaluation shall be required to determine the following:

a. The handling qualities must be satisfactory when using thrust cutback procedures (all engines operative) in the most critical configurations, weight, and center of gravity. Any speed excursions during and after the thrust cutback must be easily controllable by the pilot and at no time may the speed decrease below $V_2$. $V_2$ provides the necessary maneuver and stall margins for engine out turns of $15^o$ bank and a $15^o$ overshoot.

b. The handling qualities must be satisfactory with a simulated engine failure in the most critical configurations, weight, and center of gravity. Any speed excursions during and after the thrust cutback must be easily controllable by the pilot and at no time may the speed decrease below $V_2$. $V_2$ provides the necessary maneuver and stall margins for engine out turns of $15^o$ bank and a $15^o$ overshoot.

c. The handling qualities must be satisfactory with an automatic thrust advance during the transition from a low power setting to a high power setting due to the thrust advance associated with engine failure.

d. The flightcrew workload must be satisfactory when accomplishing the thrust cutback procedure. The pilot flying should be able to perform the thrust cutback procedure without the assistance of the other pilot (pilot-not-flying not essential to the procedure).

7. <u>Flight Guidance Considerations</u>

a. If a flight director is used for takeoff, the flight director guidance should be accurate and reliable during all foreseeable events. If it is not accurate or does not provide proper guidance during the thrust cutback procedure, it should be deactivated for takeoff. If the proposed procedure does not include the use of a flight director for thrust cutbacks below 1,500 feet, and operational test and evaluation shall be required to determine whether any special training or currency is required.

b. If an autopilot and/or flight director is used during the thrust cutback procedure, an operational test and evaluation shall be required to determine the following:

1) The guidance and/or control provided must be accurate and reliable throughout takeoff, initial climb, thrust cutback, and subsequent transition to normal climb-out.

2) The guidance and/or control provided must continue to be accurate during and after an engine failure at any point in the procedure.

3) The guidance and/or control must provide, achieve, and maintain at least the approved normal all-engine climb speed during the initial climb and thrust cutback.

4) The guidance an/or control provided must ensure that any speed losses during a transition are small and recovery to target speed is prompt. Any speed excursions during and after the thrust cutback must be easily controllable by the pilot and at no time may the speed decrease below $V_2$. $V_2$ provides the necessary maneuver and stall margins for engine out turns of 15° bank and a 15° overshoot. A transition in this case means setting cutback thrust and pitch over or an engine failure after thrust cutback. I

NOTE: If an autopilot is used during takeoff or engaged after takeoff and used during the thrust cutback procedure, the flight guidance provided (either flight director provided or non-flight director provided) must be sufficient to accurately monitor the performance of the autopilot.

8. Flightcrew Situational Awareness Considerations:

a. Alternative noise abatement procedures should include methods to enhance overall flightcrew awareness to the uniqueness of the procedure such as pre-takeoff briefings, special crew coordination call-outs, but settings, and other operator devised methods.

b. If it has been determined that the aircraft has undetectable thrust loss or engine failure characteristics, an engine thrust loss or failure detection system shall be required.

~~ATTACHMENT 2~~

**EXAMPLES OF**

**STANDARD CLOSE-IN NOISE ABATEMENT PROCEDURES**

ATC#4-21

Standard Alternative 1 - Cutback Before Cleanup Below 1,000' AGL

a. This alternative procedure requires the use of an automatic thrust cutback system, and a GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL. I

b. Takeoff and climb at an airspeed of $V_2$ + X knots until a safe obstacle clearance altitude or at an altitude of at least 400 feet AGL, whichever is higher. I

c. At an altitude of 400 feet or above, arm or initiate the automatic thrust cutback and decrease pitch while maintain $V_2$ + X knots. The thrust may be set to not lower than a cutback thrust setting necessary to maintain climb radients specified by FAR 25.111(c)(3) unless an automatic thrust restoration system is available. At no time will the thrust be reduced below a 0% gradient all engine. I

d. Continue to climb at an airspeed of $V_2$ + X knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile. I

Standard Alternative 2 - Cutback Before Cleanup Below 500' AGL

a. This alternative procedure requires the use of an automatic thrust cutback system, an automatic thrust advance system, a flight director system capable of providing appropriate guidance throughout the procedure, an autopilot system capable of flying the procedure, and A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL. It must be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain the gradients specified for this alternative procedure. It must also be shown that it is improbable that the automatic thrust advance system will fail to restore at least sufficient thrust to maintain the engine inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention under any circumstances where there is a performance or thrust degradation or engine loss.

b. Takeoff and climb at an airspeed of $V_2 + X$ knots until a safe obstacle clearance altitude or at an altitude of at least 400 feet AGL whichever is higher. I

c. At an altitude of 400 feet or above arm or initiate the automatic thrust cutback and decrease pitch while maintaining $V_2 + X$ knots. The thrust may be set to not lower than a cutback thrust setting necessary to maintain 0% all engine gradient. I

d. Continue to climb at an airspeed of $V_2 + X$ knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile. I

Standard Alternative 3 - Cutback Before Cleanup Above 1,000' AGL

a. Takeoff and climb at an airspeed of $V_2$ + X knots until attaining a safe obstacle clearance altitude or at least 1,000 feet AGL whichever is higher. I

b. At an altitude of 1,000 feet or above simultaneously initiate thrust cutback and decrease pitch while maintaining an airspeed of $V_2$ + X knots. I

c. The climb gradients may be reduced to not lower than 0% all engine if automatic thrust advance systems are available provided: I

1) It can be shown that in the event of an engine failure that it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the gradients specified in FAR 25.111(c)(3) without any pilot intervention, and

2) A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet is installed.

3) Continue to climb at an airspeed of $V_2$ + X knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile. I

[redacted]

**EXAMPLES OF**

**STANDARD FAR-OUT NOISE ABATEMENT PROCEDURES**

Alternative 4 - Cleanup Below 1000' AGL Before Cutback

a. Takeoff and climb at an airspeed of $V_2 + X$ knots until attaining a safe obstacle clearance altitude or at least 500' AGL whichever is higher. I

b. At an altitude of 500' or above, decrease pitch and accelerate to $V_2f$ while retracting flaps on schedule.

c. After attaining zero flaps, reduce thrust to not lower than a cutback thrust setting necessary to maintain the takeoff path engine - inoperative climb gradients specified by FAR 25.111(c)(3).

d. If automatic thrust cutback and automatic thrust advance systems are available, the climb gradients may be reduced to not lower than 0% all engine provided. I

1) It can be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain a gradient of not lower than 0% all engine.

2) It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the engine-inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

3) A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL is installed.

NOTE: An automatic thrust cutback system is not required if the procedure prohibits thrust cutback below 1000'.

e. Continue climb at an airspeed of $V_2 + X$ knots at the cutback thrust setting. When clear of the noise sensitive area or at 3000' AGL, set climb thrust and initiate a normal climb profile. I

Alternative 5 - Partial Cleanup Below 1000' AGL Before Cutback

a. Takeoff and climb at an airspeed of $V_2 + X$ knots until attaining a safe obstacle clearance altitude or at least 500' AGL which is higher. I

b. At an altitude of 500' or above decrease pitch, and retract flaps to an intermediate (notched) flap setting and accelerate to an airspeed consistent with the intermediate flap setting.

c. After attaining the intermediate flap setting and an appropriate airspeed for that flap setting, reduce thrust to not lower than a cutback thrust setting necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111 (c)(3).

d. If automatic thrust cutback and automatic thrust advance systems are available, the gradients may be reduced to not lower than 0% all engines provided:

1) It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the engine-inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

2) It can be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain a gradient of not lower than 0% all engine. I

3) A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL is installed.

NOTE: An automatic thrust cutback system is not required if the procedure prohibits thrust cutback below 1000'.

d. Continue climb at an airspeed appropriate for the intermediate flap setting at the cutback thrust setting. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and complete flap retraction on schedule. Establish a normal climb profile.

Alternative 6 - Cleanup Before Cutback Above 1000' AGL

a. Takeoff and climb at an airspeed of $V_2 + X$ knots until attaining a safe obstacle clearance altitude or at least 1000' AGL whichever is higher. I

b. At an altitude of 1000' or above, decrease pitch and accelerate to $V_2f$ while retracting flaps on schedule. I

c. After attaining zero flaps, reduce thrust to not lower than a cutback thrust setting necessary to maintain a takeoff path engine-inoperative climb gradient specified by FAR 25.111(c)(3).

d. If an automatic thrust advance system is available the engine-inoperative climb gradients may be reduced to not lower than 0% all engine provided. I

1) It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance system will fail to restore at least sufficient thrust to maintain the engine-inoperative gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

2) A GPWS capable of alerting the flightcrew of any descent which occurs below 1500 feet AGL is installed.

e. Continue climb at an airspeed of $V_2f + X$ knots at the cutback thrust setting. When clear of the noise sensitive area or at 3000' AGL, set climb thrust and initiate a normal climb profile. I

**ATA PROPOSED**
**NOISE ABATEMENT PROCEDURES**
**JULY 17,1990**

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## PURPOSE

To establish a regulatory requirement for pilot actions to achieve standard noise abatement profiles. To accomplish this, two standard profiles are proposed.

(a) CLOSE-IN [less than 3 nm (nominal)]

1. Takeoff and climb at an airspeed of $V_2$+10-20 KTS, until attaining an altitude of 1000 ft. above airport elevation (AAE).

2. Aircraft pitch will not exceed manufacturer's recommended maximum pitch attitude required to maintain $V_2$+10-20 KTS.

3. Upon attaining 1000 ft. AAE, reduce thrust in compliance with FAR 25.111 (c) 3. Allow for 1.2% climb gradient (2 engine aircraft), 1.5% (3 engine aircraft) and 1.7% (4 engine aircraft), or 0% climb gradient for aircraft equipped with Auto Thrust Recovery devices and enhanced GPWS. Maintain $V_2$+10-20 KTS and remain in takeoff flap configuration.

4. Continue climb at $V_2$+10-20 KTS until 3000 ft. AAE and clear of noise sensitive area whereupon, set climb thrust, accelerate to $V_{ZF}$ and retract flaps on schedule.

(b) FAR-OUT (beyond 3 miles)

1. Takeoff and climb at an airspeed of $V_2$+10-20 KTS until attaining an altitude of 1500ft. above airport elevation (AAE).

2. Aircraft pitch will not exceed manufacturer's recommended maximum pitch attitude required to maintain $V_2$+10-20 KTS.

3. (High Bypass Engines)
Upon attaining 1500 ft. AAE set climb thrust, accelerate to the zero flap minimum safe maneuvering speed ($V_{ZF}$) while retracting laps on schedule

(Low Bypass Engines)
Upon attaining 1500 ft. AAE accelerate to the zero $V_{ZF}$ minimum safe maneuvering speed while retracting flaps on schedule and set climb thrust.

---

**FAR-OUT *(CONTINUED)***

4. **Continue climb at $V_{ZF}$ minimum safe maneuver speed to an altitude of not less than 3000 ft. AAE, and initiate normal climb profile.**

**The selection of a minimum altitude of 1000 ft. AAE provides the following:**

1. **Increases safety through standardization.**
2. **Improves noise abatement for communities.**
3. **Aligns the noise abatement profile with the TCAS Resolution Advisory envelope which provides all escape options at 1000 ft. AGL and above.**
4. **Establishes a minimum performance standard for each aircraft engine/airframe combination.**

***Stage III aircraft provide the highest level of noise technology currently available, consequently, local use restrictions should not be permitted to discriminate against any aircraft which qualifies as Stage III. Airports/communities must not impose noise restrictions which would necessitate thrust cuts below 1000ft.***

**# # #**

**FAA /Initial Proposal**
**Presented To The**
**Aircraft Takeoff Noise Abatement**
**Joint FAA/Industry Working Group**
**June 19, 1990**

ATCH 4-31

Aircraft Takeoff Noise Abatement
Joint FAA/Industry Working Group

INITIAL AIRCRAFT TAKEOFF NOISE ABATEMENT CONFERENCE
June 19, 1990 - 9:00AM - 5:00PM
ALPA's Facilities, Room 804
8th Floor, 1625 Massachusetts Ave., S.W., Washington, DC

PROBLEM: Because of a variety of unique runway/community situations and the varying performance and noise characteristics of different aircraft, there has been an increasing use of non-standard takeoff noise abatement procedures. In some cases communities have established criteria that cause operators to use special procedures to remain competitive in that community's air transportation market. Although a special (nonstandard) procedure may not have a significant effect when considered alone, there is a potential for a negative effect on safety when these special procedures vary from airport to airport and runway to runway. The lack of standardization generally has a negative effect on safety. There is a need to address these potentially negative effects and to establish a program to ensure that adequate safety levels are maintained. A profileration of special noise abatement takeoff and initial climb procedures could degrade safety because of the following:

1). The complexity of the special procedures could divert attention from normal pre-departure tasks (ATC clearances, cockpit setup, checklists, briefing emergency procedures).

2). Possible diversion of attention from normal tasks during takeoff and initial climb (performance monitoring, see and avoid, ATC, weather).

3). Thrust reductions at low altitude, for noise abatement purposes, will reduce obstacle clearance, could require abrupt changes in flight path, complicate emergencies such as engine failure, and reduce aircraft performance in adverse weather such as windshear/icing.

4). Possible increase in human errors due to confusion between nonstandard and standard procedures.

5). Exposure to failure risks earlier and at lower altitudes when such failures can be induced by power changes, mode switching, and configuration changes.

OBJECTIVES: The objectives of the aircraft takeoff Noise Abatement meeting are to bring interested parties together, discuss and review the issues in detail (both national issues and John Wayne issues), present proposals for resolution of identified problems, make tentative decisions on the approach to take in view of the requirement of FAR 91.87(f), and to establish a smaller working group to work out the details of an acceptable alternatives.

ATCA 4-37

Proposed Objectives: The following objectives are proposed for the joint FAA/Industry effort to resolve takeoff noise abatement issues:

- Define a satisfactory noise abatement procedure or a combination of procedures that is or are consistent with safe operations and agree to adopt the procedure or combination of procedures as industry standards.

- Establish a standard noise abatement procedure or a combination of standard procedures that cannot be changed by an individual operator or approved by an individual FAA Flight Standards District Office without a complete FAA/Industry review and agreement concerning the overall affect the change will have on systemwide operational safety and noise relief benefits.

- Make the standard noise abatement procedure(s) the only procedures(s) available for flightcrew training and use at any airport where noise relief can be achieved by adjusting the takeoff and initial climb (vertical) profile of the aircraft.

- Establish a process which precludes a proliferation of non-standard noise abatement procedures for unique airport/community conditions.

Proposed Resolution: The following proposal is offered for the purpose of initiating discussion and to serve as a basis for exploring alternative approaches and shall not be construed as an FAA recommendation or position.

1. Develop and publish a revision to Advisory Circular (AC) 91-53 to establish a set of standard noise abatement procedures from which an operator can select one or two of the procedures as the standard for a particular airplane type. The (AC) would specify that an operator could select a procedure or a combination of procedures which is or are optimal for that airplane type. The operator would then train flightcrews who operate that airplane type to use only the selected procedure or combination of procedures. Once the standard procedure or procedures were adopted by a operator, they would be used for all airport/community environments, as appropriate. For the purpose of standardization, efficiency of training, noise abatement and airport/community planning up to three standard takeoff procedures for each airplane type could be used. The three standard takeoff procedures for the purpose of this duscussion are referred to as follows:

- o Normal takeoff procedure
- o Standard close-in takeoff noise abatement procedure
- o Standard far-out takeoff noise abatement procedure

2. Normal Takeoff Procedure: The normal takeoff procedure may be developed by the manufacturer and adopted by the operator or it may be a procedure developed by the operator. The normal takeoff procedure would be used on runways where noise abatement is not a factor or on runways where the standard noise abatement procedures do not provide any significant or the desired noise relief. The normal takeoff procedure would be reviewed and approved at the local FAA District Office level provided it is consistent with the criteria listed below:

a) Set takeoff thrust as specified by the operator (either maximum takeoff thrust or an appropriate reduced takeoff thrust setting).

b) After takeoff, climb at an airspeed of $V_2$ + 10 to 20 knots until attaining an altitude specified by the operator (either a standard altitude or an obstacle clearance altitude) but not lower than 500 feet.

c) At the altitude specified by the operator, decrease pitch and accelerate to $V_zf$ while retracting flaps on schedule (if flaps are not used for takeoff, decrease pitch and accelerate to climb speed).

d) After attaining $V_zf$, or at a point specified by the operator, set climb thrust and initiate a climb profile as specified by the operator.

3. Standard Noise Abatement Procedures: Perceived takeoff noise depends on the airplane/engine combination, takeoff configuration, performance characteristics, and the takeoff initial climb procedure used as well as the environmental (noise sensitive) characteristics of the airport. An operator may determine that for a particular airplane type the normal takeoff procedure

provides the best overall relief at noise sensitive airports (including both close-in and far-out noise sensitive areas). For another airplane type, an operator may determine that a single noise abatement procedure is appropriate for both close-in and far-out noise sensitive areas and as a result the operator would adopt and use a normal takeoff procedure and a single standard takeoff noise abatement procedure. However, for many airplanes in operation today, there is an optimal takeoff procedure which provides the most relief for close-in noise sensitive areas and another takeoff procedure which provides the most relief for noise sensitive areas that are further out from the runway. As a result, an operator may determine that three takeoff procedures need to be adopted for the type of airplane operated and the environmental characteristics of the airports served. An operator would not be authorized to use more than three standard takeoff procedures (a normal, close-in, and a far-out takeoff procedure).

a. Noise abatement procedures are either developed by the manufacturer and adopted by the operator or they are developed by the operator. There are two general categories of noise abatement procedures.

1) One category provides relief to noise sensitive areas that are "close-in" to the end of the takeoff runway. The procedures in this category generally involve climbing in the takeoff configuration to a specified altitude and then simultaneously decreasing pitch and setting a predetermined cutback thrust and overflying the noise sensitive area before accelerating, retracting flaps, and setting climb power.

2) The other category provides relief to noise sensitive areas that are "far-out" from the end of the takeoff runway. The procedures in this category generally involve climbing in the takeoff configuration to a specified altitude and then decreasing pitch to accelerate while retracting flaps and after the flaps are retracted (or partially retracted) setting a predetermined cutback thrust and overflying the noise sensitive area before setting climb power.

b. The optimum type of procedure for either a close-in or far-out noise sensitive area is highly dependent on the airplane's takeoff configuration and performance characteristics as well as the takeoff weight. If it is determined that both close-in and far-out noise abatement procedures are needed for a particular airplane type, an operator would be able to select two standard noise abatement procedures and train flightcrews in their use. The operator, in this case, would have to instruct flightcrews on which procedure to use for particular runway/noise sensitive area environment.

c. Obstacle clearance requirements must be considered when selecting an altitude at which either a flap configuration change is initiated or at which a thrust cutback is initiated for noise abatement purposes. Obstacle clearance altitudes are a variable altitude depending on the airport and surrounding terrain or obstacles. The amount of noise relief provided by a standard noise abatement procedure at a particular runway/noise sensitive area environment is also dependent on the altitude at which either the flap configuration change is initiated (with subsequent thrust cutback) or at which the thrust cutback is initiated in the takeoff configuration. By adjusting this initiating altitude, noise relief can be optimized for a particular runway/noise sensitive area environment. The initiating altitude would be the only variable permitted for particular standard noise abatement procedure. The operator would have to specify the initiating altitude for a particular runway/noise sensitive area environment.

d. When the initiating altitude is established at the lower altitudes, the available airspace in which to maneuver is decreased. In addition, decreased thrust levels, decreases performance margins. Therefore, in order to ensure adequate safety, specific criteria would have to be met before approving the use of an initiating altitude below 1,000 feet and/or approving the use of a cutback thrust setting lower than that necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3) (assuming an engine failure without any thrust advance on the remaining engine(s)). The general criteria that would have to be met for each procedure and airplane type are as follows:

(1) The procedure would have to be operationally evaluated and tested by the FAA for the airplane type. The factors and specific criteria that would be considered by the FAA are outlined in Attachment 1. The Director, Flight Standards Service (AFS-1) would be responsible for reviewing the results of the tests and if satisfactory approving the procedure for the particular airplane type. Once a specific procedure for an airplane type has been approved by AFS-1, it could then be approved for specific operators.

(2) Any procedure which specifies an initiating altitude below 1,000 feet and a cutback thrust of less than that necessary to maintain the FAR 25.111(c)(3) gradients would have to incorporate an automatic thrust cutback system, an automatic thrust advance system, and a GPWS capable of alerting the flightcrew of any descents which occur below 1,500 feet AGL. The automatic thrust cutback system, however, is not required if the procedure prohibits thrust cutback below 1,000 feet AGL. In no case shall the takeoff path engine-inoperative climb gradient be less than 0%.

(3) Any procedure which specifies an initiating altitude of 1,000 feet or above and a cutback thrust of less than that necessary to maintaining the FAR 25.111(c)(3) gradients would have to incorporate an automatic thrust advance system and a GPWS capable of alerting the flightcrew of any descents which occur below 1,500 feet AGL. In no case shall the takeoff path engine-inoperative climb gradient be less than 0%.

f. In the interest of keeping the standard noise abatement procedures to a minimum, operators would be able to request that the procedures outlined in Attachment 2 (close-in) and Attachment 3 (far-out) be approved for their operations. The approval level would be indicated for each procedure. An operator may request approval of a procedure different than the ones outlined in Attachments 2 and 3 by submitting a request through the assigned POI to AFS-1 for appropriate processing.

ATTACHMENT 1
OPERATIONAL TEST AND EVALUATION
CONSIDERATIONS

1. Definition of Cutback Thrust: Cutback thrust means a thrust setting that in the event of an engine failure is not less than the setting necessary to maintain the takeoff path engine-inoperative climb gradients specified for a particular alternative noise abatement procedure. These thrust settings are determined without considering the subsequent addition of thrust on the remaining engine(s) from a pilot action or an automatic thrust advance system. Thrust cutback means the act of setting cutback thrust.

2. Minimum Thrust Cutback Altitude: The setting of the cutback thrust for noise abatement purposes shall not be initiated below 400 feet AGL.

3. Reduced Thrust Takeoffs: Takeoffs using reduced thrust for the purpose of reducing engine maintenance cost should be prohibited if it causes the use of an alternative noise abatement procedure which includes a thrust cutback below 1000 feet AGL.

4. Flight Path (Pitch Angle) Change Considerations:

If a proposed procedure requires an initial pitch attitude that is greater than the normal operational pitch limit specified in the manufacturers flightcrew operating manual, an operational test and evaluation shall be required to determine whether special training and/or currency or other provisions are required. Factors that should be considered in determining whether special training or currency should be required include the following:

a. The rotation rates required to achieve the target pitch altitudes. The required rotation rates cannot exceed the values established by the manufacturer for normal flight operations.

b. Difficulty of speed control when transitioning from full power to cutback thrust during all engine operation and operations where an engine failure occurs during the transition.

c. The pilots visibility at the reference eye position and the alert eye position.

5. Thrust Setability Considerations:

a. The target cutback thrust setting should be determined (calculated) before takeoff. If an automatic thrust cutback feature is used, a minimum acceptable thrust cutback setting should be available so that the flightcrew can monitor the performance of the automatic thrust cutback feature.

b. The thrust cutback must be initiated by a single flightcrew action when the aircraft is at or above the established cutback height. (For example: manual throttle reduction or activation of a switch which initiates an automatic thrust cutback feature.)

c. If thrust cutback is accomplished by manual throttle reduction below a height of 1,500 feet, operational tests and evaluation must be conducted to determine whether a pilot of average skill can quickly (within 5 seconds), accurately, and reliably set the target cutback thrust without undue attention. During these tests, the absolute value of the mean deviation from the target setting shall be determined. This mean deviation shall thereafter be added to the target thrust settings to establish the minimum settings that can be used in actual operations.

d. If thrust cutback is accomplished by automatic devices, an operational test and evaluation shall be required to determine the following:

1). The flightcrew must be able to adequately monitor the performance of the automatic devices and such monitoring must not require an inordinate amount of flightcrew attention;

2). The thrust cutback must be smoothly, accurately, and reliably set;

3). It must be shown to be improbable that the automatic thrust cutback feature has unacceptable failure modes;

4). Any detected failure of the automatic thrust cutback system is adequately annunciated or otherwise clearly apparent to the flightcrew, and

5). The automatic thrust cutback feature must be inhibited below 400 feet AGL or a higher specified height.

e. If an automatic thrust advance system is used, an operational test and evaluation shall be required to determine the following:

1). The thrust advance is immediate and provides, without flight crew intervention sufficient thrust to maintain at least the FAR 25.111 engine-out gradients.

2). The required thrust advance setting is quickly, accurately, and reliably set.

3). It must be shown to be improbable that the automatic thrust advance feature has unacceptable failure modes.

4). That any detected failure of the automatic thrust advance system is adequately annunciated or otherwise clearly apparent to the flightcrew.

6. <u>Aircraft controllability considerations</u>. An operational test and evaluation shall be required to determine the following:

a. The handling qualities must be satisfactory when using thrust cutback procedures (all engines operative) in the most critical configurations, weight, and center of gravity. Any speed excursions during and after the thrust cutback must be easily controllable by the pilot and any speed loss must not exceed $(V_2 + X) -5$ with speeds less than $(V_2 + X) -2$ not to exceed 10 seconds.

b. The handling qualities must be satisfactory with a simulated engine failure in the most critical configurations, weight, and center of gravity. Any speed losses resulting from the engine failure before, during, and after the thrust cutback must be easily controllable by the pilot and any speed loss must not exceed $(V_2 + X) -5$ with speed less than $(V_2 + X) -2$ not to exceed 10 seconds.

c. The handling qualities must be satisfactory when automatic thrust advance system during the transition from a low power setting to a high power setting due to the thrust advance associated with engine failure.

d. The flightcrew workload must be satisfactory when accomplishing the thrust cutback procedure. The pilot flying should be able to perform the thrust cutback procedure without the assistance of the other pilot (pilot-not-flying not essential to the procedure).

7. <u>Flight Guidance Considerations</u>

a. If a flight director is used for takeoff the flight director guidance should be accurate and reliable during all foreseeable events. If it is not accurate or does not provide proper guidance during the thrust cutback procedure, it should be deactivated for takeoff. If the proposed procedure does not include the use of a flight director for thrust cutbacks below 1,500 feet, an operational test and evaluation shall be required to determine whether any special training or currency is required.

b. If an autopilot and/or flight director is used during the thrust cutback procedure, an operational test and evaluation shall be required to determine the following:

1). The guidance and/or control provided must be accurate and reliable throughout takeoff, initial climb, thrust cutback, and subsequent transition to normal climb-out.

2). The guidance and/or control provided must continue to be accurate during and after an engine failure at any point in the procedure.

3). The guidance and/or control must provide, achieve, and maintain at least the approved normal all-engine climb speed during the initial climb and thrust cutback.

4). The guidance and/or control provided must ensure that any speed losses during a transition are small and recovery to target speed is prompt. Any speed loss must not exceed $(V_2 + X) -5$ with speeds less than $(V_2 + X) -2$ not to exceed 10 seconds. A transition in this case means setting cutback thrust and pitch over or an engine failure after thrust cutback.

NOTE: If an autopilot is used during takeoff or engaged after takeoff and used during the thrust cutback procedure, the flight guidance provided (either flight director provided or non-flight director provided) must be sufficient to accurately monitor the performance of the autopilot.

8. Flightcrew Situational Awareness Considerations.

a. Alternative noise abatement procedures should include methods to enhance overall flightcrew awareness to the uniqueness of the procedure such as pre-takeoff briefings, special crew coordination call-outs, bug settings, and other operator devised methods.

b. If it has been determined that the aircraft has undetectable thrust loss or engine failure characteristics, an engine thrust loss or failure detection system shall be required.

[redacted]

Standard Close-In Noise Abatement Procedures

Standard Alternative 1 - Cutback Before Cleanup Below 1,000' AGL

a. This alternative procedure requires the use of an automatic thrust cutback system, an automatic thrust advance system, and a GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL. It must be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3). It must also be shown that is improbable that the automatic thrust advance system will fail to provide at least sufficient thrust to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention.

b. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until a safe obstacle clearance altitude or at an altitude of at least 500 feet AGL, whichever is higher.

c. At an altitude of 500 feet or above initiate the automatic thrust cutback and decrease pitch while maintaining $V_2$ + 10 to 20 knots. The thrust may be set to not lower than a cutback thrust setting necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3).

d. Continue to climb at an airspeed of $V_2$ + 10 to 20 knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile.

Standard Alternative 2 - Cutback Before Cleanup Below 500' AGL

a. This alternative procedure requires the use of an automatic thrust cutback system, an automatic thrust advance system, a flight director system capable of providing appropriate guidance throughout the procedure, an autopilot system capable of flying the procedure, and a GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL. It must be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain the gradients specified for this alternative procedure. It must also be shown that it is improbable that the automatic thrust advance system will fail to restore at least sufficient thrust to maintain the engine inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention under any circumstances where there is a performance or thrust degradation or engine loss.

b. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until a safe obstacle clearance altitude or at an altitude of at least 400 feet AGL whichever is higher.

c. At an altitude of 400 feet or above initiate the automatic thrust cutback and decrease pitch while maintaining $V_2$ + 10 to 20 knots. The thrust may be set to not lower than a cutback thrust setting necessary to maintain a takeoff path engine-inoperative climb gradient of at least 0%. The cutback thrust setting used in this situation must produce at least a 4% climb gradient with all engines operative.

e. Continue to climb at an airspeed of $V_2$ + 10 to 20 knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile.

Standard Alternative 3 - Cutback Before Cleanup Above 1,000' AGL

a. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until attaining a safe obstacle clearance altitude or at least 1,000 feet AGL whichever is higher.

b. At an altitude of 1,000 feet or above simultaneously initiate thrust cutback and decrease pitch while maintaining an airspeed of $V_2$ + 10 to 20 knots. Reduce thrust to not lower than a cutback thrust setting necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3).

c). The engine-inoperative climb gradients may be reduced to not lower than 0% if automatic thrust advance systems are available provided:

a. It can be shown that in the event of an engine failure that it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the gradients specified in FAR 25.111(c)(3) without any pilot intervention, and

b. A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet is installed.

c. Continue to climb at an airspeed of $V_2$ + 10 to 20 knots. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and accelerate while retracting flaps on schedule. Establish a normal climb profile.

[redacted]

**Standard Far-Out Noise Abatement Procedures**

ATB#4 -

Alternative 4 - Cleanup Below 1000' AGL Before Cutback

a. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until attaining a safe obstacle clearance altitude or at least 500' AGL whichever is higher.

b. At an altitude of 500' or above, decrease pitch and accelerate to $V_{zf}$ while retracting flaps on schedule.

c. After attaining zero flaps, reduce thrust to not lower than a cutback thrust setting necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3).

d. If automatic thrust cutback and automatic thrust advance system are available, the engine-inoperative climb gradients may be reduced to not lower than 0% provided:

1). It can be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain a gradient of not lower than 0%.

2). It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the engine-inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

3). A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL is installed.

NOTE: An automatic thrust cutback system is not required if the procedure prohibits thrust cutback below 1000'.

e. Continue climb at an airspeed of $V_{zf}$ + 10 to 20 knots at the cutback thrust setting. When clear of the noise sensitive area or at 3000' AGL, set climb thrust and initiate a normal climb profile.

Alternative 5 - Partial Cleanup Below 1000' AGL Before Cutback

a. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until attaining a safe obstacle clearance altitude or at least 500' AGL whichever is higher.

b. At an altitude of 500' or above decrease pitch, and retract flaps to an intermediate (notched) flap setting and accelerate to an airspeed consistent with the intermediate flap setting.

c. After attaining the intermediate flap setting and an appropriate airspeed for that flap setting, reduce thrust to not lower than a cutback thrust setting necessary to maintain the takeoff path engine-inoperative climb gradients specified by FAR 25.111(c)(3).

d. If automatic thrust cutback and automatic thrust advance systems are available, the engine-inoperative gradients may be reduced to not lower than 0% provided:

1). It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance systems will fail to restore at least sufficient thrust to maintain the engine-inoperative climb gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

2). It can be shown that it is improbable that the automatic thrust cutback system will fail to set a thrust at least sufficient to maintain a gradient of not lower than 0%.

3). A GPWS capable of alerting the flightcrew of any descent which occurs below 1,500 feet AGL is installed.

NOTE: An automatic thrust cutback system is not required if the procedure prohibits thrust cutback below 1000'.

d. Continue climb at an airspeed appropriate for the intermediate flap setting at the cutback thrust setting. When clear of the noise sensitive area or at 3,000 feet AGL, set climb thrust and complete flap retraction on schedule. Establish a normal climb profile.

<u>Alternative 6</u> - Cleanup Before Cutback Above 1000' AGL

a. Takeoff and climb at an airspeed of $V_2$ + 10 to 20 knots until attaining a safe obstacle clearance altitude or at least 1000' AGL whichever is higher.

b. At an altitude of 1000' or above, decrease pitch and accelerate to $V_{z}f$ while retracting flaps on schedule.

c. After attaining zero flaps, reduce thrust to not lower than a cutback thrust setting necessary to maintain a takeoff path engine-inoperative climb gradient specified by FAR 25.111(c)(3).

d. If an automatic thrust advance system is available the engine-inoperative climb gradients may be reduced to not lower than 0% provided

1). It can be shown that in the event of an engine failure, it is improbable that the automatic thrust advance system will fail to restore at least sufficient thrust to maintain the engine-inoperative gradients specified by FAR 25.111(c)(3) without any pilot intervention, and

2). A GPWS capable of alerting the flightcrew of any descent which occurs below 1500 feet AGL is installed.

e. Continue climb at an airspeed of $V_{z}f$ + 10 to 20 knots at the cutback thrust setting. When clear of the noise sensitive area or at 3000' AGL, set climb thrust and initiate a normal climb profile.

## UNITED AIR LINES

## NOISE ABATEMENT TAKEOFF TEST PROFILES

| | |
|---|---|
| AIRCRAFT MAKE/MODEL/SERIES: | Boeing - 737-300 CFM 56-3-$B_2$ 22,000 lbs. |
| CONDITIONS: | Standard Day/Sea Level |
| SCOPE OF DATA POINTS: | From Point of Takeoff Thrust Application (Brake Release) to 4,000 feet AGL |
| PROCEDURES: | - Normal UAL Takeoff and Climb Procedures, Except as Specified by the Individual Test Profile |
| | - Normal Rotation Rates at $V_R$ |
| | - Initial Pitch Attitude to Maintain $V_2$ +20, Except as Otherwise Specified by the Individual Test Profile |

### SERIES A

### NORMAL NOISE ABATEMENT TAKEOFF TEST PROFILES

1. After takeoff, climb to initiating altitude at $V_2$ + 20
2. At the initiating altitude, simultaneously decrease pitch to maintain approximately 1/2 the deck angle and initiate flap retraction while accelerating.
3. Retract flaps on speed schedule.
4. At 0 flaps or $V_{zf}$, set climb thrust and maintain $V_{zf}$ to 3,000 feet, then accelerate to 250 kts while continuing climb to 4,000 feet.

| RUN | T.O. THRUST | ALTITUDE INITIATING | WEIGHT |
|---|---|---|---|
| A-1 | Max Rated | 1,000 ft. | Heavy (approx. 130k) |
| A-2 | Max Rated | 1,000 ft. | Medium (approx. 110k) |
| A-3 | Max Rated | 1,000 ft. | Light (approx. 90k) |
| A-4 | Reduced T.O. Thrust | 1,000 ft. | Medium |
| A-5 | Reduced T.O. Thrust | 1,000 ft. | Light |
| A-6 | Max Rated | 800 ft. | Medium |
| A-7 | Reduced T.O. Thrust | 800 ft. | Medium |
| A-8 | Reduced T.O. Thrust | 800 ft. | Light |

Date: 11/15/90

## SERIES B

## NORMAL NOISE ABATEMENT TAKEOFF TEST PROFILES

1. After takeoff, climb to initiating altitude at $V_2$ + 20.
2. At the initiating altitude, set climb thrust, then simultaneously decrease pitch to approximately 1/2 deck angle and initiate flap retraction while accelerating.
3. Retract flaps on speed schedule.
4. At 0 flaps maintain $V_{ZF}$ to 3,000 feet then accelerate to 250 kts while continuing climb to 4,000 feet.

| RUN | T.O. THRUST | INITIATING ALTITUDE | WEIGHT |
|---|---|---|---|
| B-1 | Max Rated | 1,000 feet | Medium |
| B-2 | Reduced T.O. Thrust | 1,000 feet | Medium |
| B-3 | Reduced T.O. Thrust | 800 feet | Medium |

## SERIES C

## CLOSE-IN NOISE ABATEMENT TAKEOFF TEST PROFILES

1. After takeoff, climb to initiating altitude at the speed or pitch limit indicated for each run.
2. At the initiating altitude, cutback thrust to a setting which results in the engine-out climb gradient indicated for each run and simultaneously decrease pitch to maintain the airspeed indicated for each run.
3. Continue to climb at the specified speed with flaps in the takeoff configuration to 3,000 feet.
4. At 3,000 feet, set climb thrust and adjust pitch while simultaneously initiating flap retraction and accelerating to retract flaps on schedule.
5. Continue to accelerate to 250 kts while continuing to climb to 4,000 feet.

| RUN | T.O. THRUST | INITIATING ALTITUDE | CUTBACK THRUST CLIMB GRADIENT | SPEED PITCH LIMIT | WEIGHT |
|---|---|---|---|---|---|
| C-1 | Max Rated | 1,000 ft. | 1.2% | $V_2 + 20$ | Heavy |
| C-2 | Max Rated | 1,000 ft. | 1.2% | $V_2 + 20$ | Medium |
| C-3 | Max Rated | 1,000 ft. | 1.2% | $V_2 + 20$ | Light |
| C-4 | Max Rated | 1,000 ft. | 0% | $V_2 + 20$ | Medium |
| C-5 | Max Rated | 1,000 ft. | 1.2% | Limit Pitch ($V_2 + X$) | Light |
| C-6 | Max Rated | 800 ft. | 1.2% | $V_2 + 20$ | Medium |
| C-7 | Max Rated | 800 ft. | 0% | $V_2 + 20$ | Medium |
| C-8 | Max Rated | 800 ft. | 1.2% | Limit Pitch ($V_2 + X$) | Light |
| C-9 | Max Rated | 500 ft. | 1.2% | $V_2 + 20$ | Medium |
| C-10 | Max Rated | 500 ft. | 0% | $V_2 + 20$ | Medium |
| C-11 | Max Rated | 500 ft. | 1.2% | Limit Pitch ($V_2 + X$) | Light |

NOTE: For Runs C-12 and C-13, the pilot will be required to aggressively and abruptly set the cutback thrust and pitch attitude at the initiating altitude.

| | | | | | |
|---|---|---|---|---|---|
| C-12 | Max Rated | 1,000 ft. | 1.2% | $V_2 + 20$ | Light |
| C-13 | Max Rated | 500 ft. | 1.2% | $V_2 + 20$ | Light |

## SERIES D

## FAR-OUT NOISE ABATEMENT TAKEOFF TEST PROFILE

1. After takeoff, climb to initiating altitude at $V_2 + 20$.
2. At the initiating altitude, simultaneously decrease pitch to approximately 1/2 deck angle and initiate flap retraction while accelerating.
3. Retract flaps on speed schedule.
4. At 0 flaps or $V_{zf}$, cutback thrust to a setting which results in the engine-out climb gradient indicated for each run.
5. Continue to climb at $V_{zf}$ to 3,000 feet.
6. At 3,000 feet, set climb thrust and accelerate to 250 kts while climbing to 4,000 feet.

| RUN | TO THRUST | INITIATING ALTITUDE | CUTBACK THRUST CLIMB GRADIENT | WEIGHT |
|---|---|---|---|---|
| D-1 | Max Rated | 1,000 ft. | 1.2% | Heavy |
| D-2 | Max Rated | 1,000 ft. | 1.2% | Medium |
| D-3 | Max Rated | 1,000 ft. | 1.2% | Light |
| D-4 | Max Rated | 1,000 ft. | 0% | Medium |
| D-5 | Reduced T.O. Thrust | 1,000 ft. | 1.2% | Medium |
| D-6 | Max Rated | 800 ft. | 1.2% | Medium |
| D-7 | Max Rated | 500 ft. | 1.2% | Medium |
| D-8 | Max Rated | 500 ft. | 0% | Medium |

## SERIES E

## MISCELLANEOUS RUN

CONDITIONS: Medium Weight, Flaps set at 5, and Max Rated Thrust

RUN E2
1. After takeoff, climb at $V_2 + 20$ to 500 ft.
2. At 500 feet, retract flaps on speed schedule.
3. At flaps 0 or $V_{zf}$, cutback thrust to a setting which results in a $V_{zf}$ engine-out climb gradient of 1.2%.
4. Continue climb at $V_{zf}$ to 3,000 feet.
5. At 3,000 feet, set climb thrust while accelerating to 250 kts and continuing climb to 4,000 feet.

RUN E3
1. After takeoff, climb at $V_2 + 20$ to 500 ft.
2. At 500 feet, retract flaps on speed schedule.
3. At flaps 0 or $V_{zf}$, cutback thrust to climb power.
4. Continue climb at $V_{zf}$ to 3,000 feet.
5. At 3,000 feet, accelerate to 250 kts and continue climb to 4,000 feet.

## SERIES N

## NORMAL TAKEOFF TEST PROFILE

**RUN N1:**

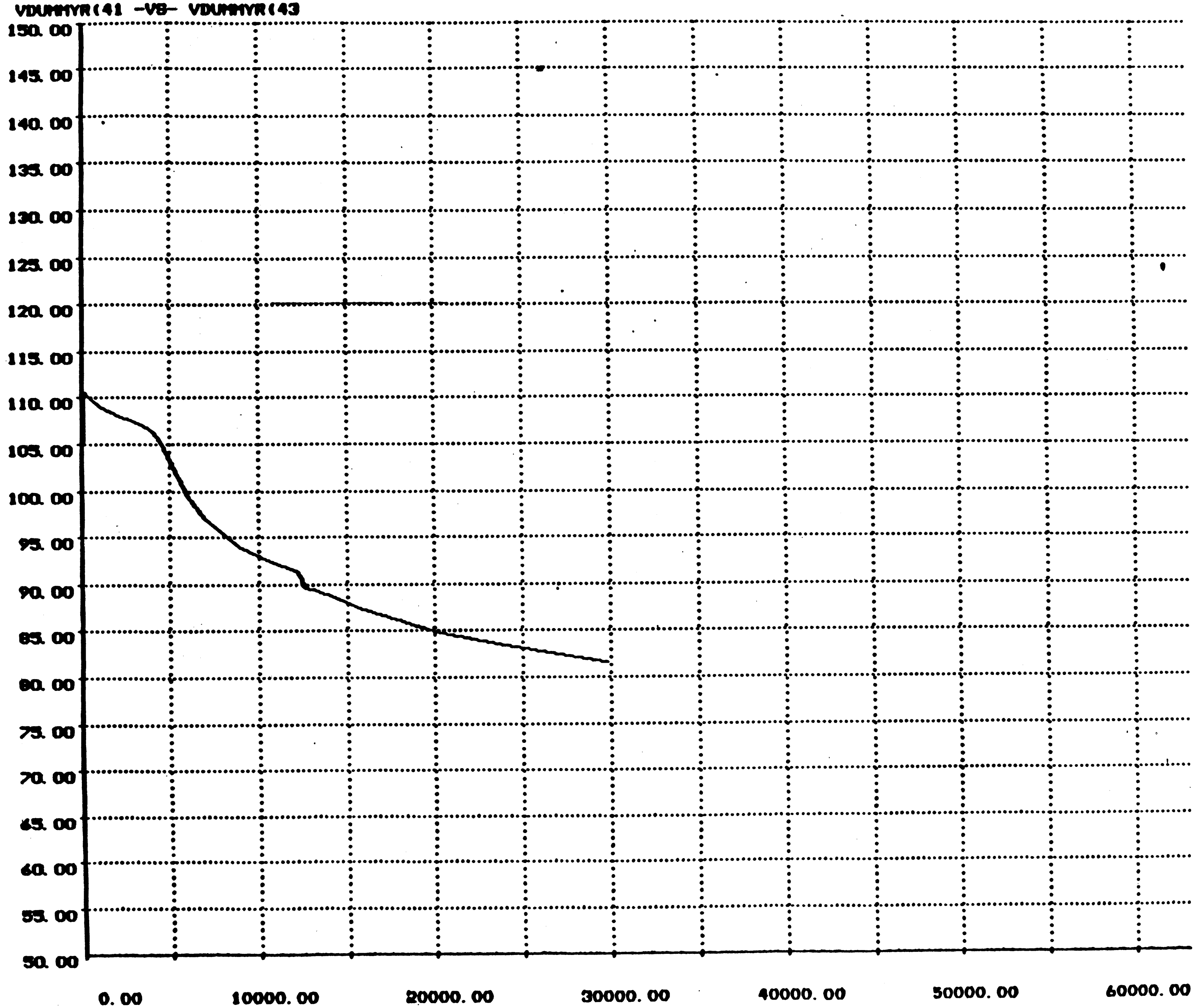
I. After takeoff, climb to initiating altitude at $V_2 + 20$.
2. At the initiating altitude, simultaneously decrease pitch to approximately 1/2 the deck angle and initiate flap retraction while accelerating.
3. Retract flaps on speed schedule.
4. At 0 flaps or $V_{ZF}$, set climb power, accelerate to 250 kts while continuing climb to 4,000 feet.

Takeoff Thrust - Max Rated Thrust

Initiating Altitude - 1,000 feet

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT)

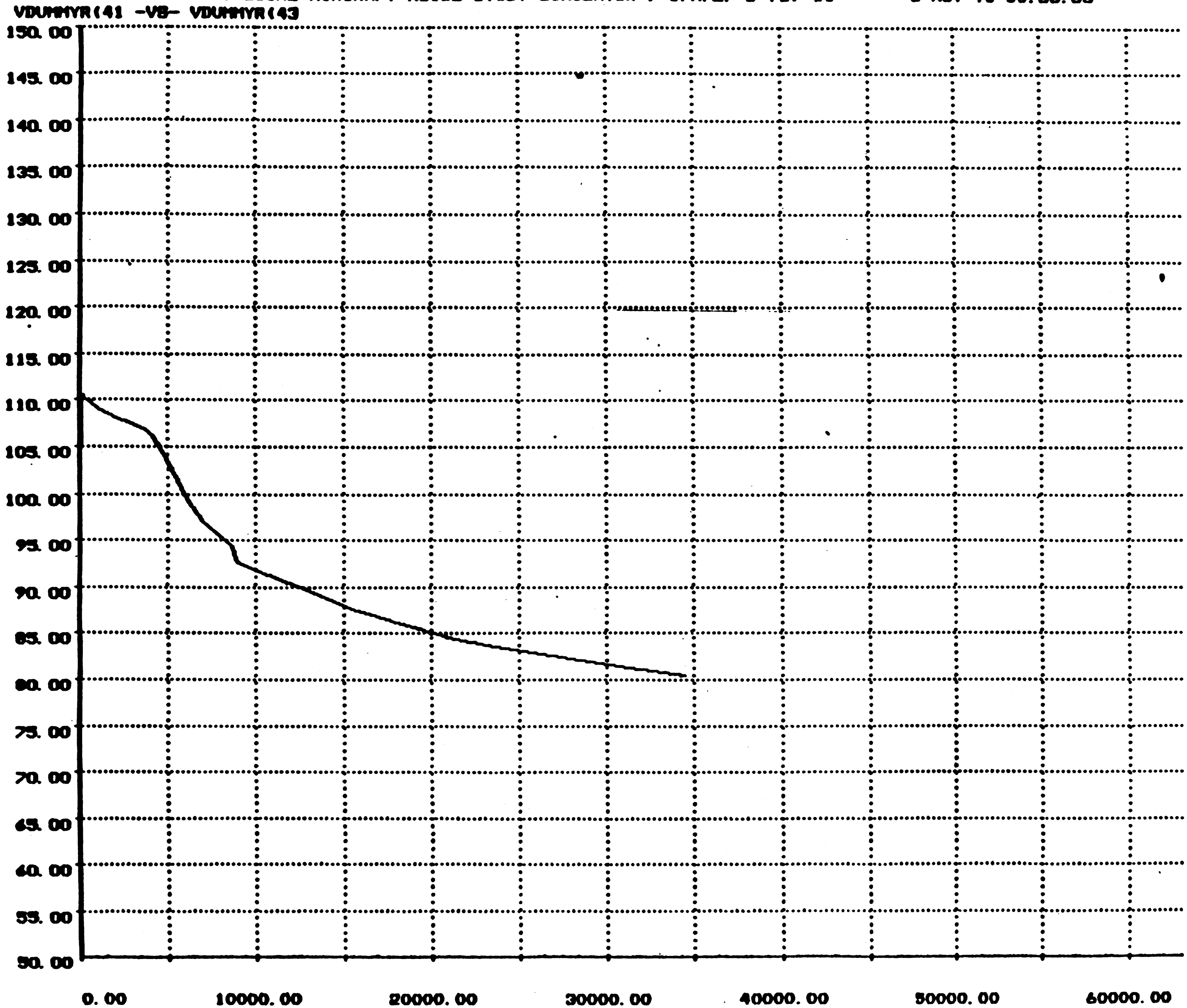
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 (A2) 6-NOV-90 01:42:24




ATCH 5-6

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) 61

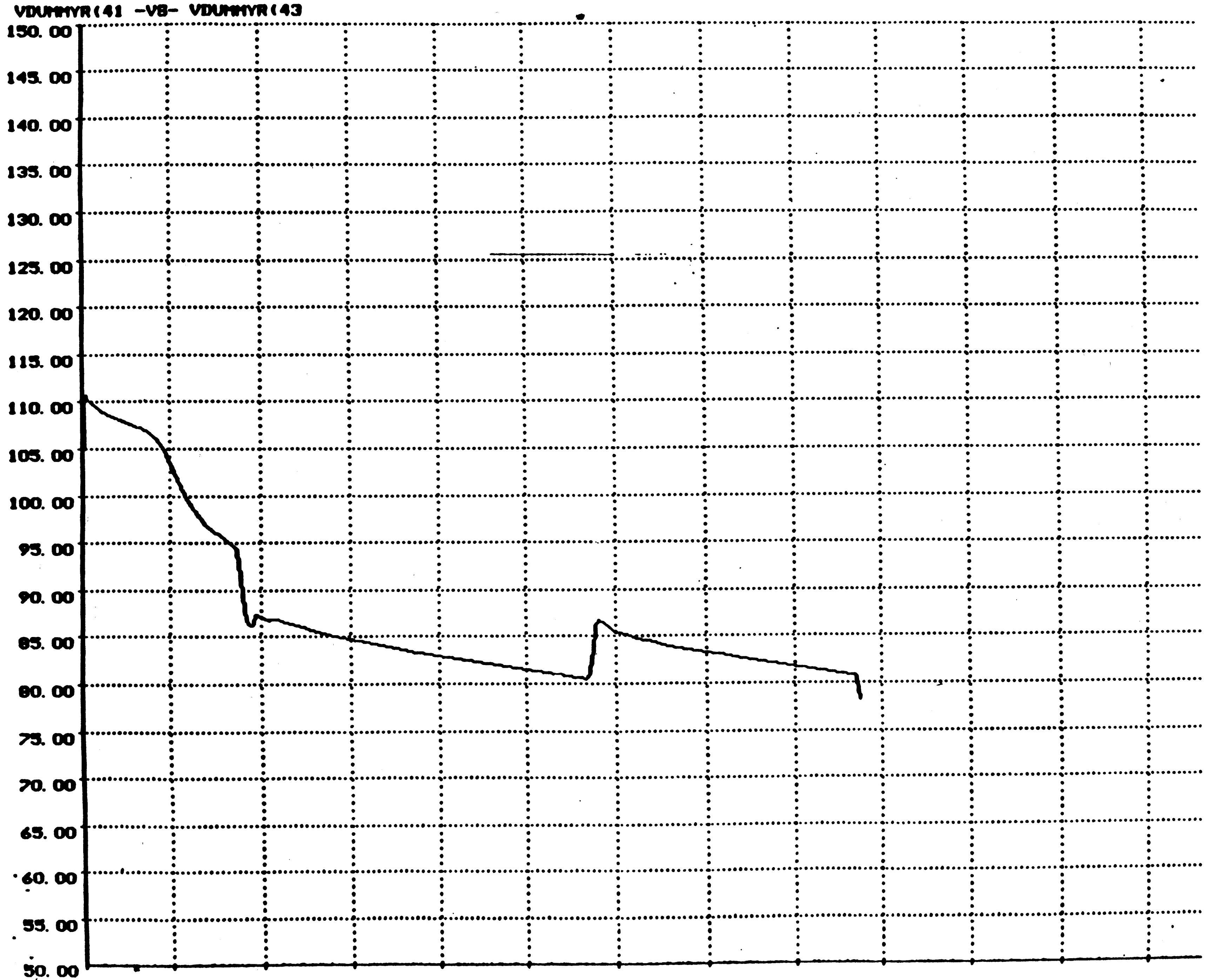
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 00:36:38




130
B1

ATCH 5-7

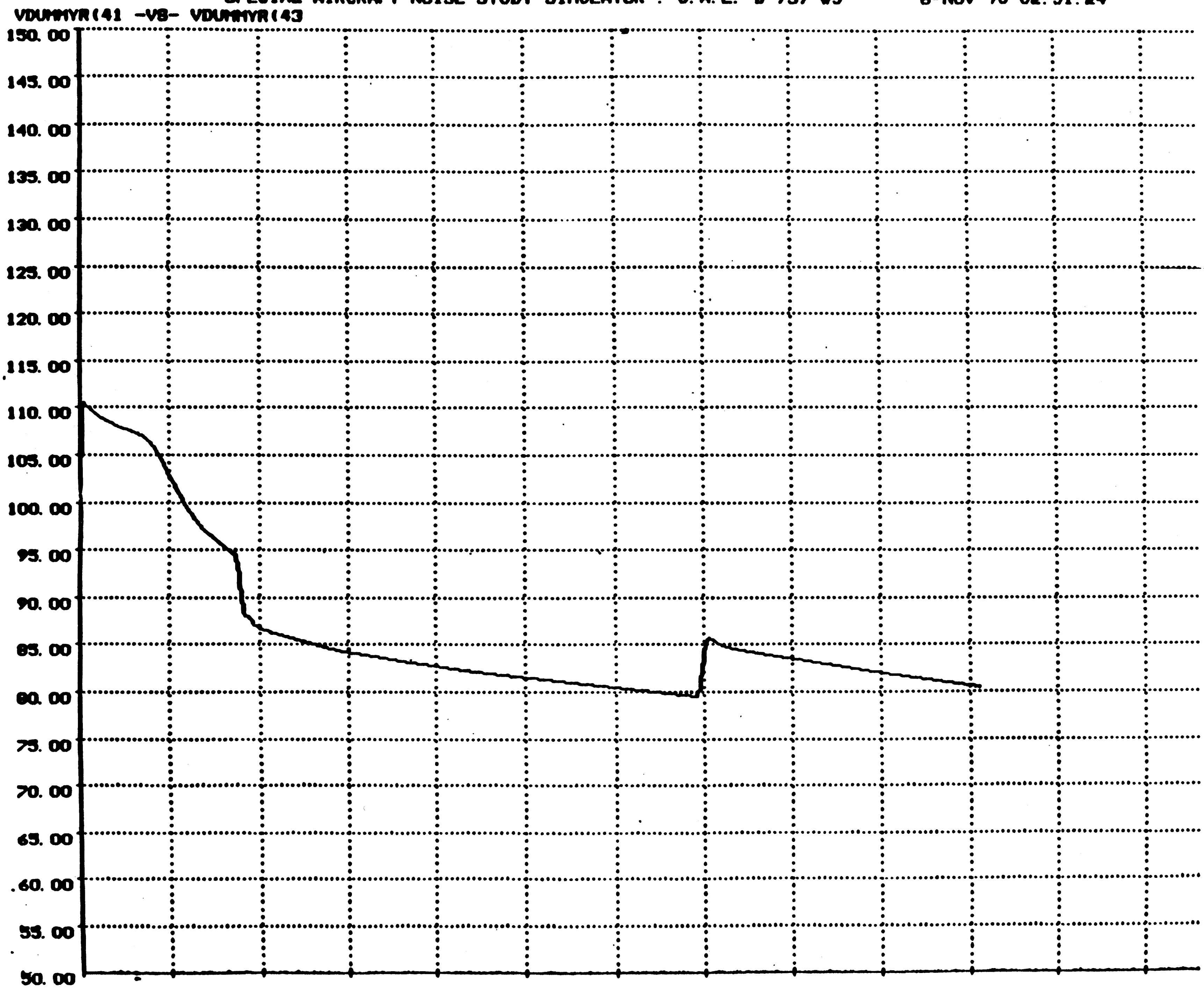
NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) C2
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 02:39:59



NOISE LEVEL (SELDB) VS DIST FROM T/O (FT)

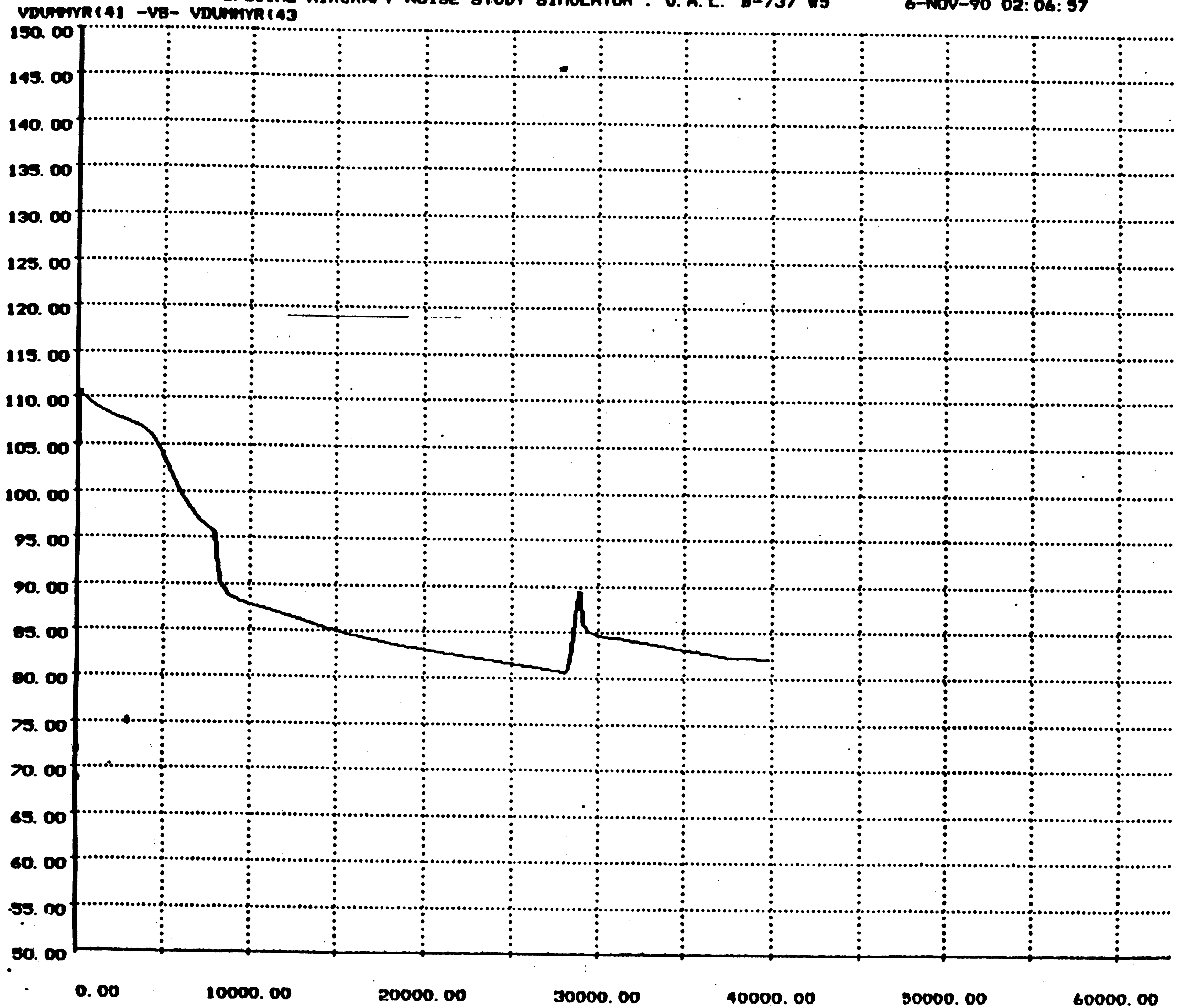
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 02:51:24

(C4)




ATCH 5-9

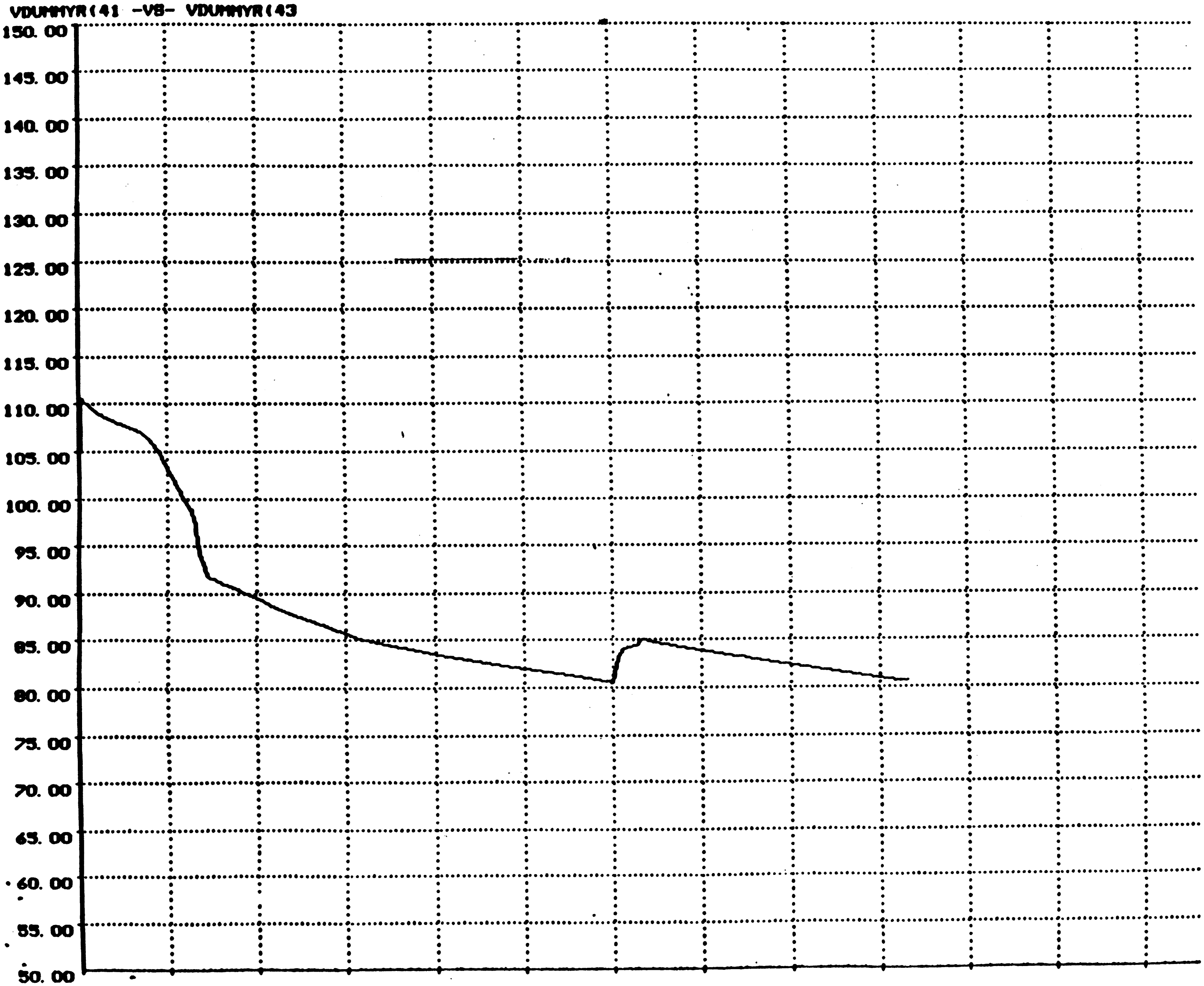
NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) CB
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 02:06:57




ATCH 5-

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) C9

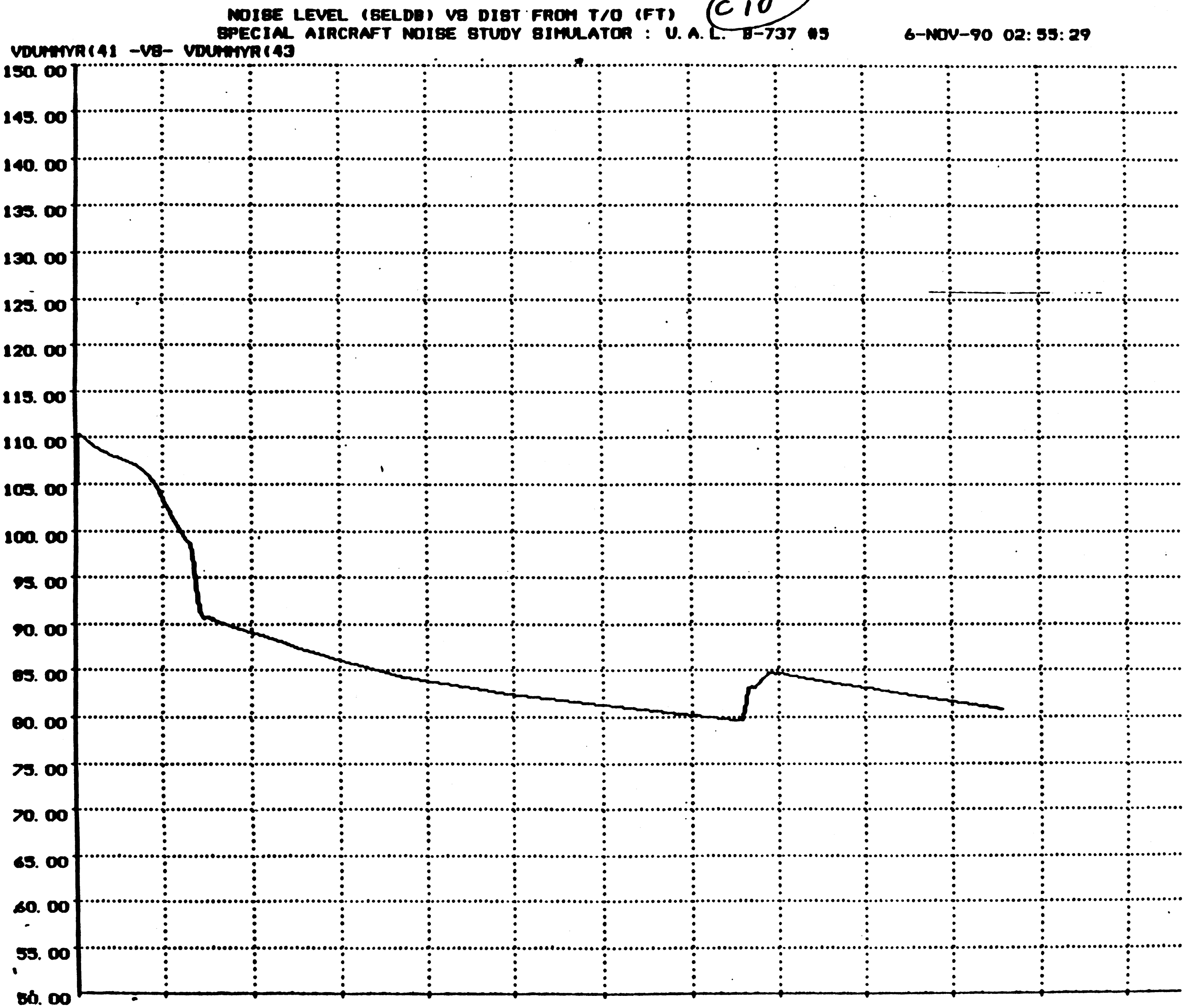
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 02:47:09




ATCH 5

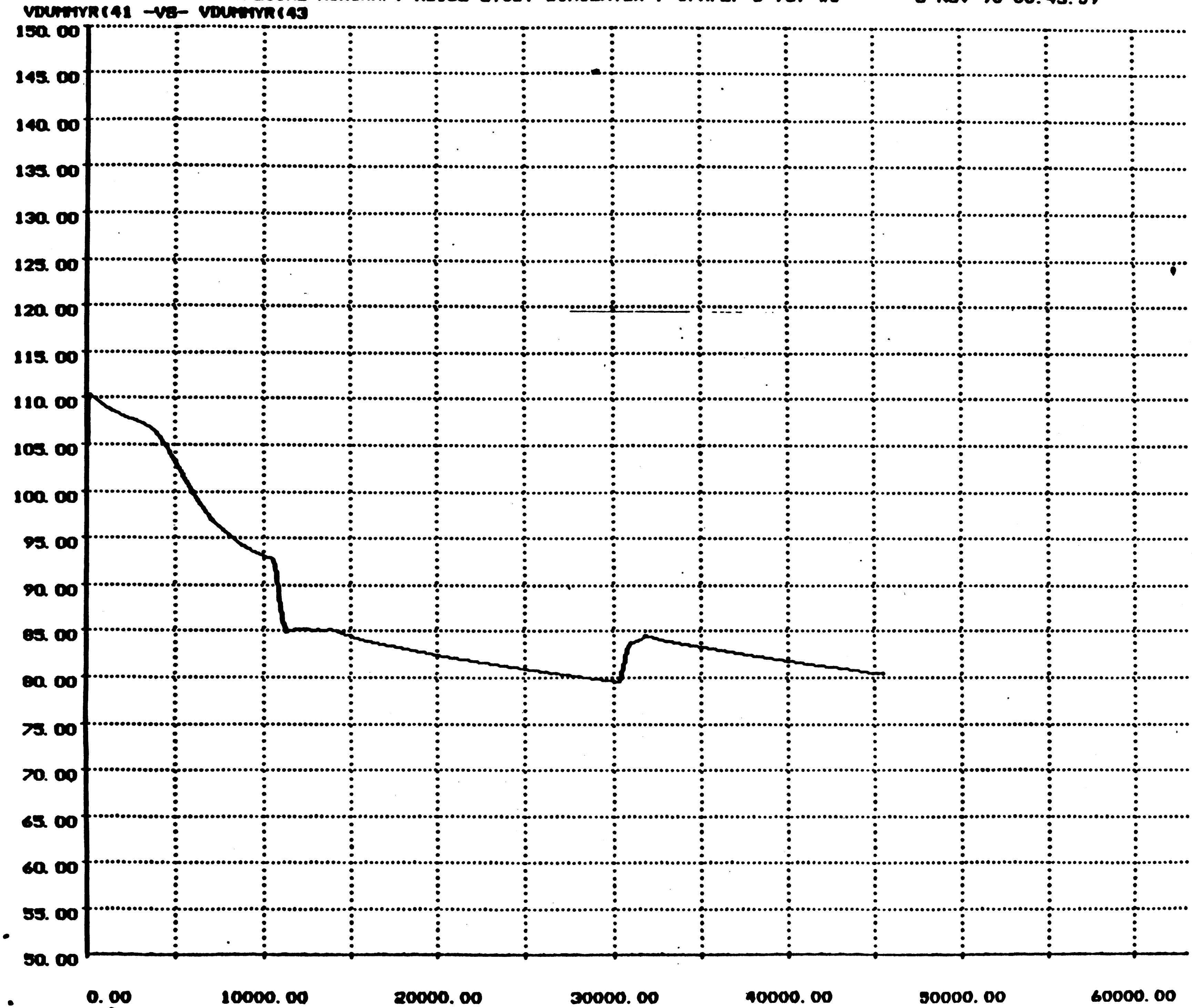
C10

ATC#5-


NOISE LEVEL (SELDB) VS DIST FROM T/O (FT)
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5
6-NOV-90 02:55:29
VDUMMYR(41 -VS- VDUMMYR(43
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
110.00
105.00
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) 1)2

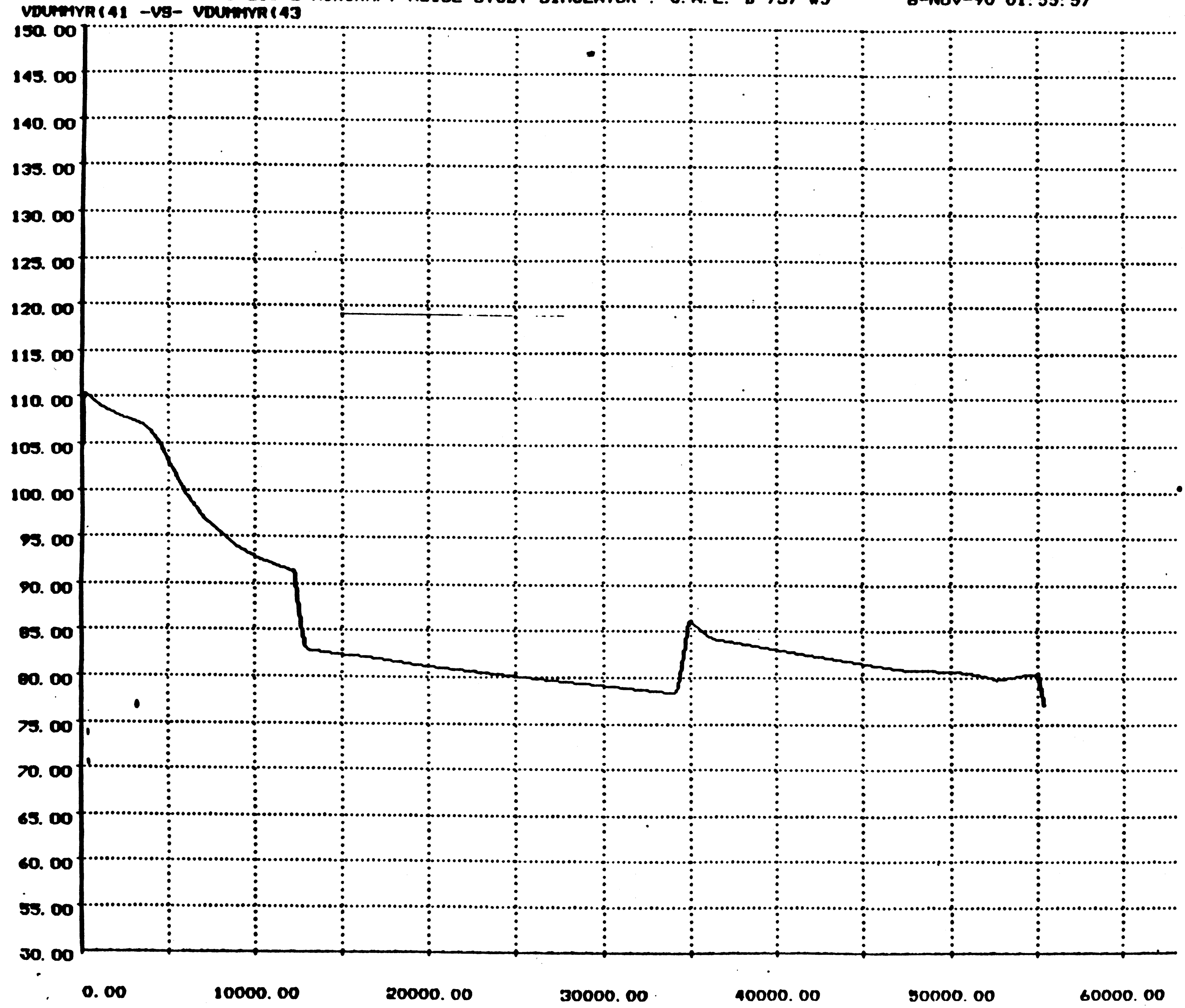
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 00:43:59



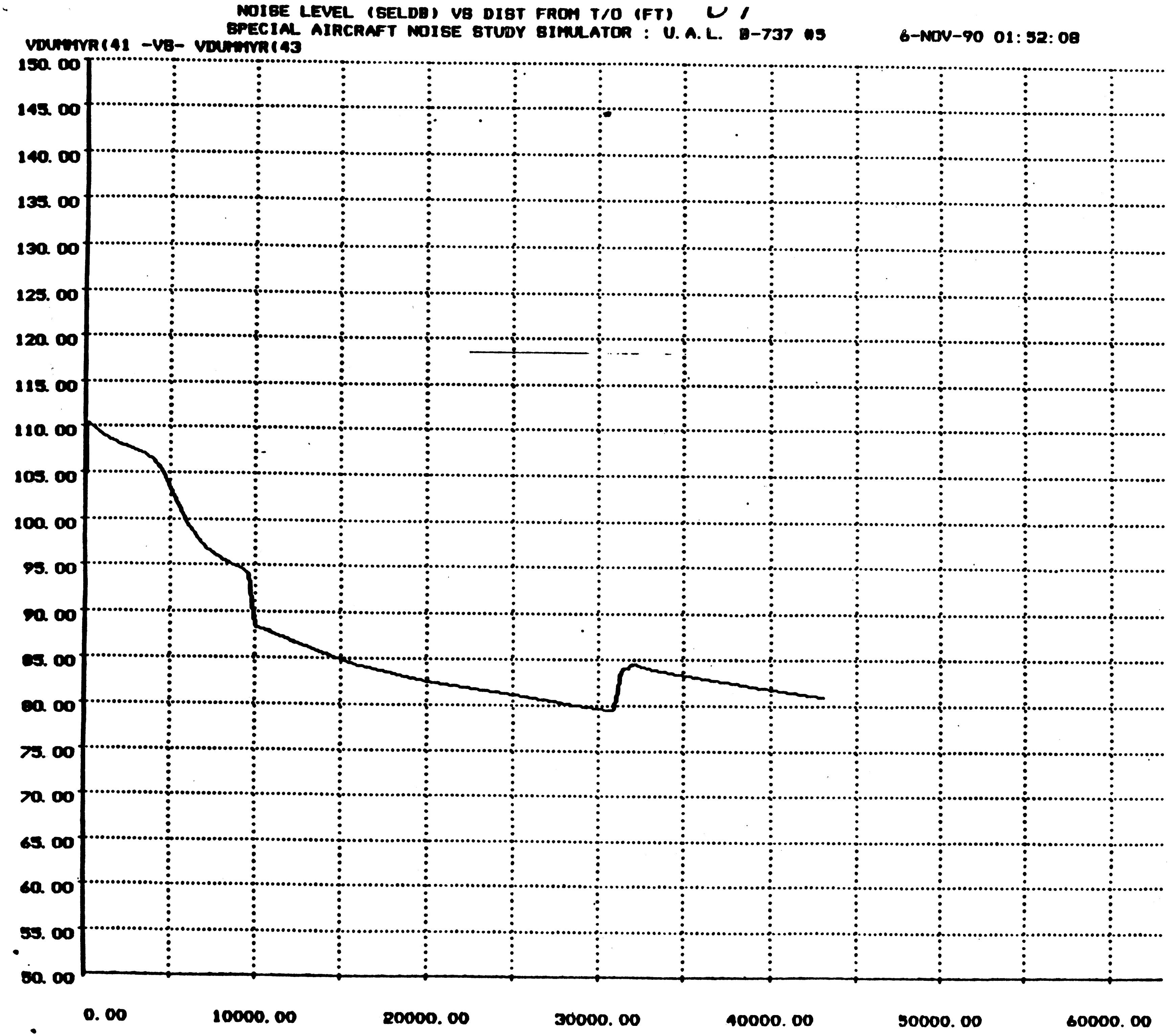

ATC1#5

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) D4

SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 01:55:57



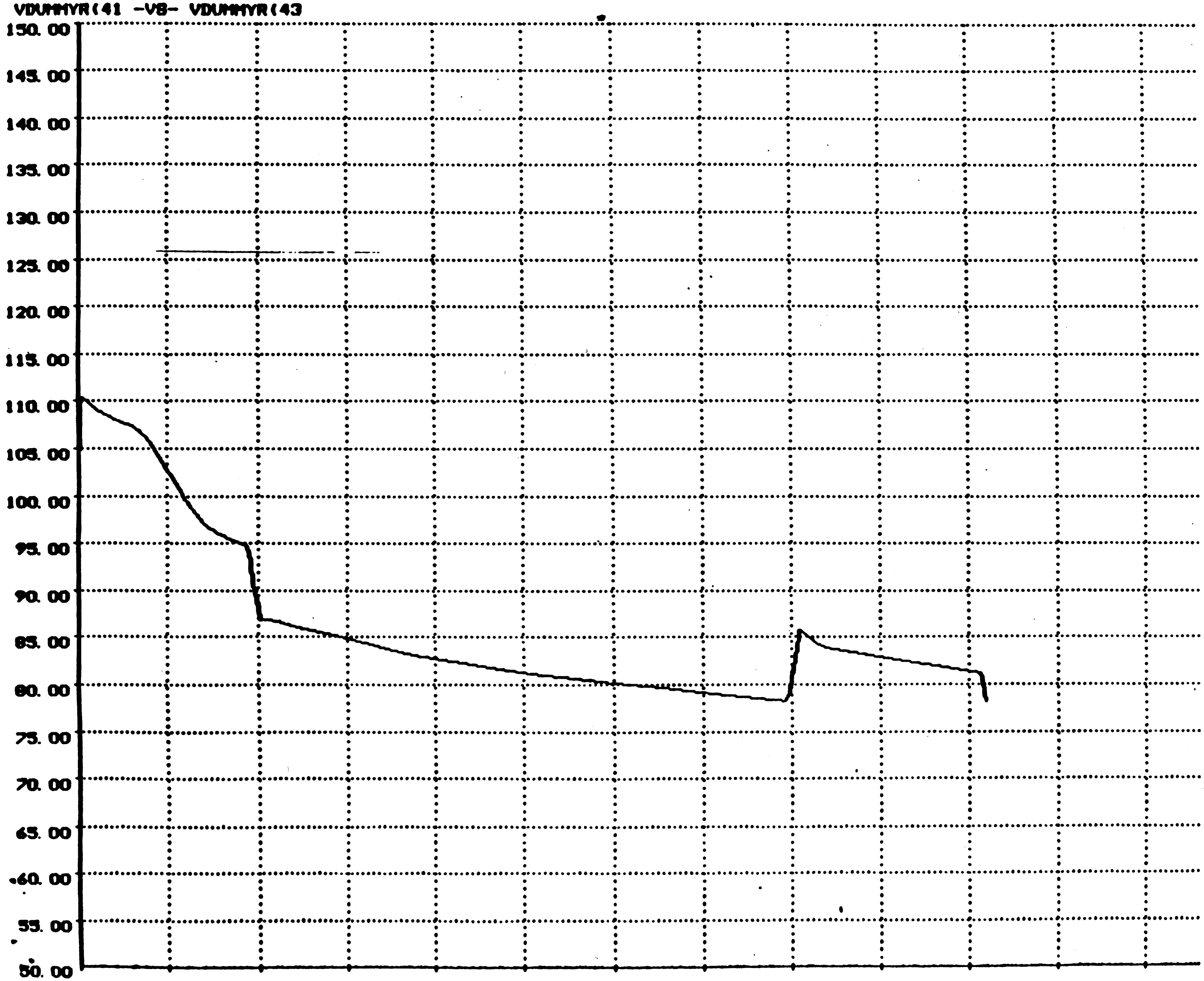

ATCH 5-1


NOISE LEVEL (SELDB) VS DIST FROM T/O (FT)
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5
6-NOV-90 01:52:08
VDUMMYR(41 -VS- VDUMMYR(43
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
110.00
105.00
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
0.00
10000.00
20000.00
30000.00
40000.00
50000.00
60000.00

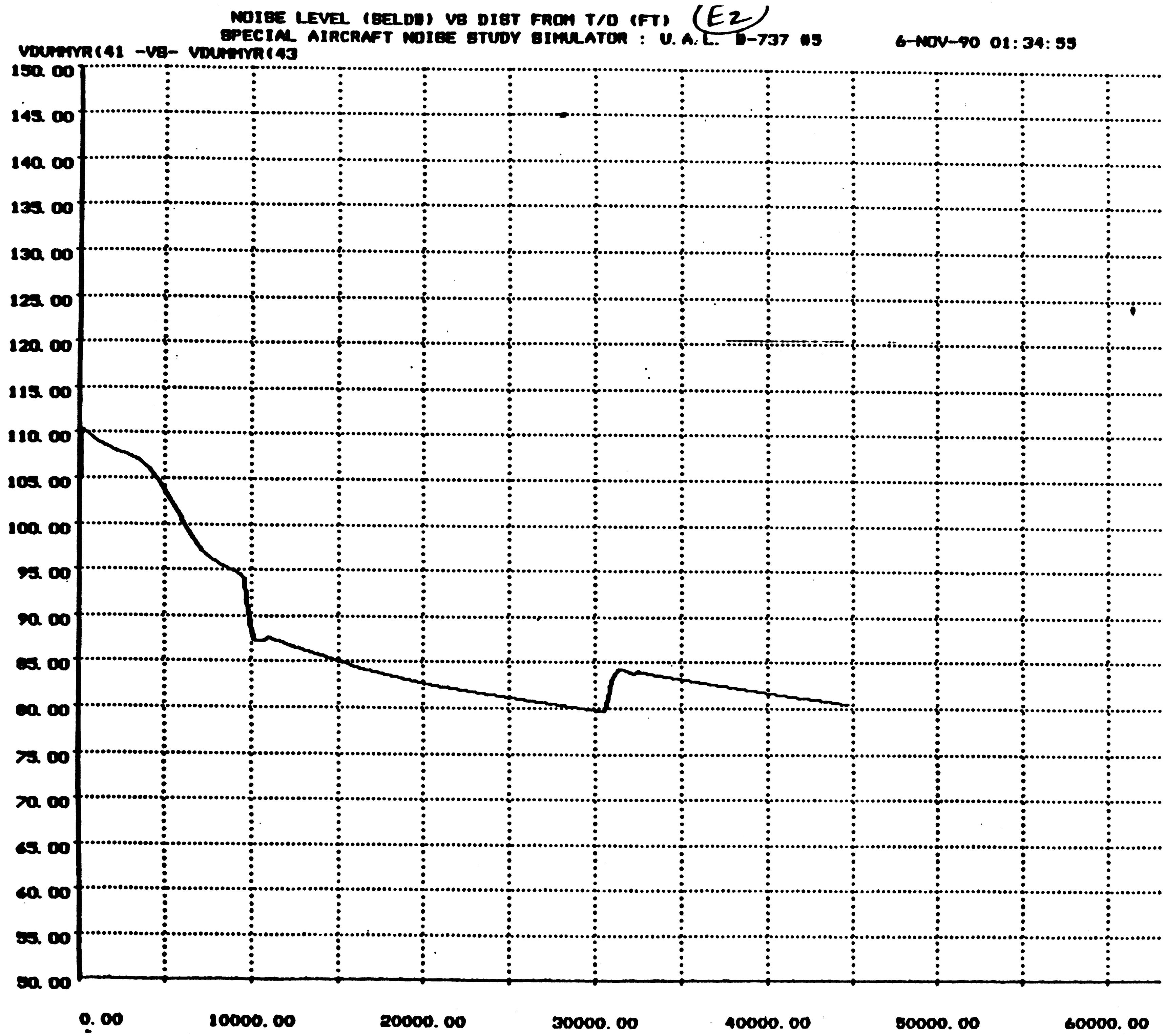
ATCH 5-1

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) D8

SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 02:35:48

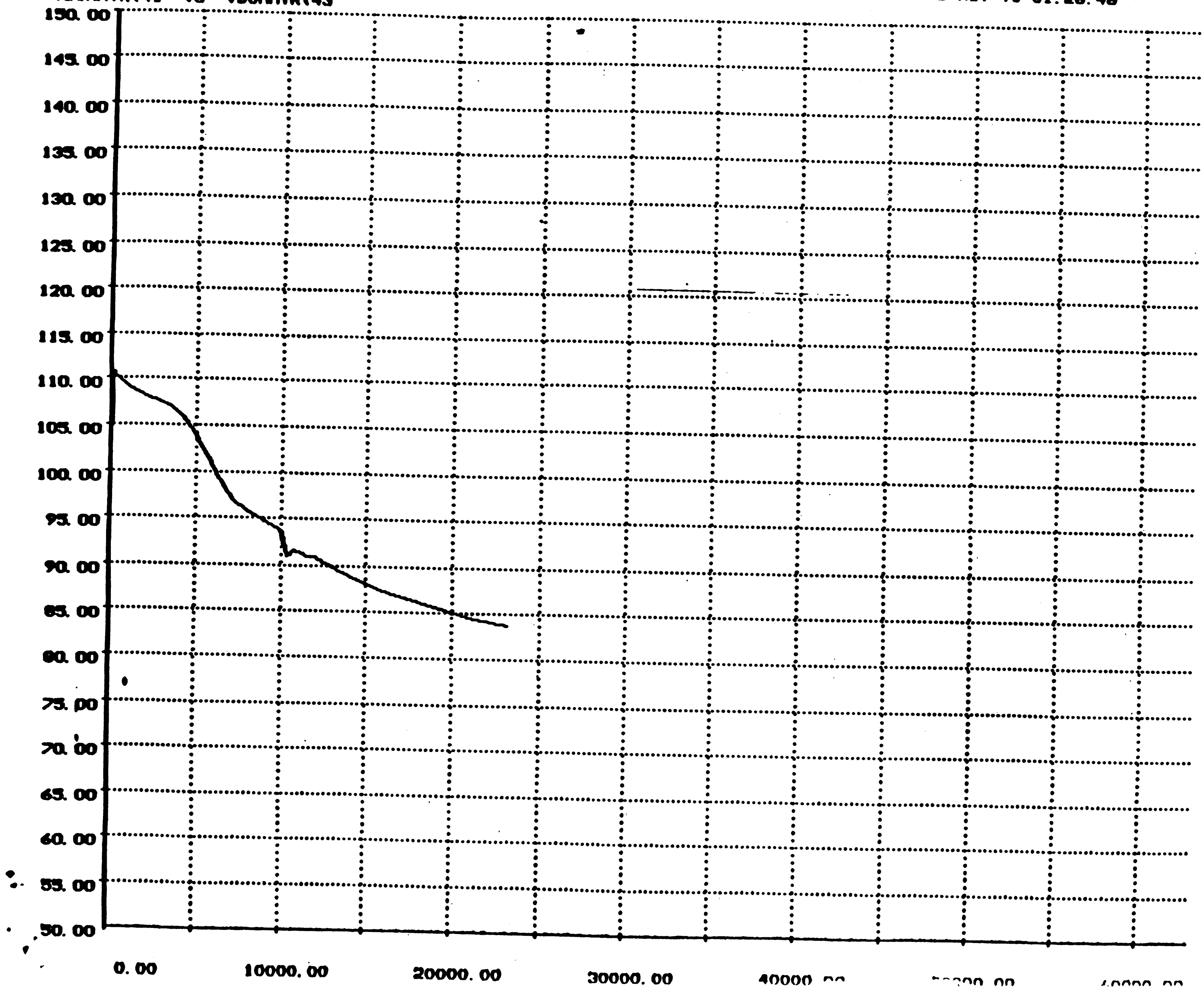



ATCH 5-1


NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) (E2)
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5
6-NOV-90 01:34:55
VDUMMYR(41 -VS- VDUMMYR(43
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
110.00
105.00
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
0.00
10000.00
20000.00
30000.00
40000.00
50000.00
60000.00

ATCH 5-71

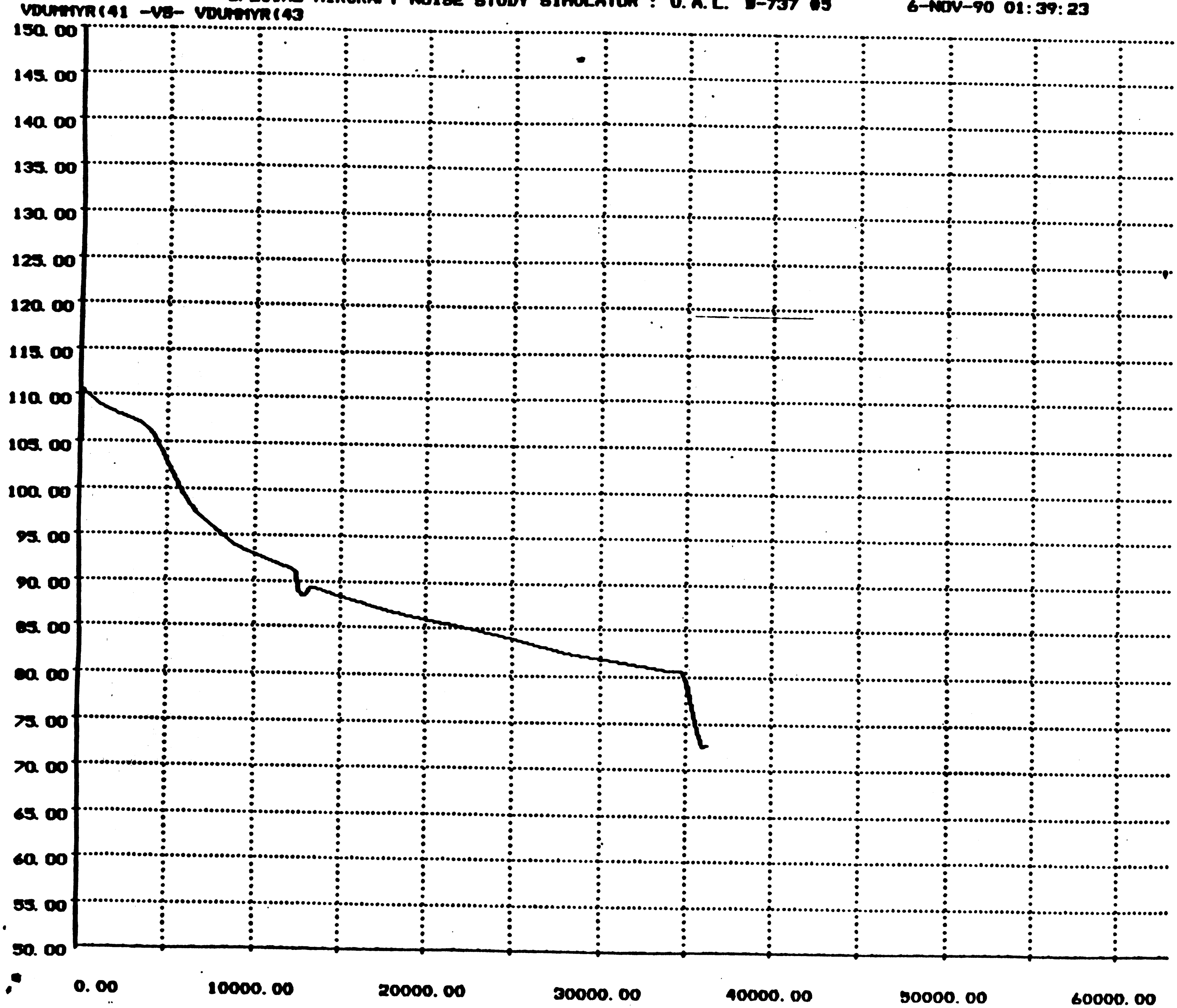
NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) E2
SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5
VDUMMYR(41 -VS- VDUMMYR(43 6-NOV-90 01:26:46




ATCH 5-18

NOISE LEVEL (SELDB) VS DIST FROM T/O (FT) N1

SPECIAL AIRCRAFT NOISE STUDY SIMULATOR : U.A.L. B-737 #5 6-NOV-90 01:39:23



MCDONNELL DOUGLAS

Douglas Aircraft Company

THOMAS M. RYAN, JR.
Vice President
Flight Operations/Safety and Training

March 11, 1991
C1-TMR-052

Mr. Charles W. Euler, APS-401
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Dear Mr. Euler:

As stated in the past (reference letter C1-JLA-TMR-90-L185, dated June 7, 1990, and letter C1-API-TMR-069, dated July 25, 1990), in the view of Douglas Aircraft Company (DAC), the present capabilities for noise abatement by means of thrust cutback are safe operations for all DAC products provided appropriate associated procedures are applied. We cannot support future regulations that negate presently approved procedures, that have been proven to be safe without a complete understanding of the overall community impact as it relates to the operation of DAC products by our customers.

Fully automatic and safe thrust cutback features, providing the capability for the pilot to preprogram the cutback maneuver on the ground with automatic operation occurring at the proper point of climbout (with no pilot action required) have been built into recent DAC designs based on anticipation of these features being required in the future for low altitude cutbacks. DAC's position still remains that all engine cutback to an engine out, zero gradient thrust level (no thrust advance on remaining engines) can safely be accomplished at altitudes as low as 500 feet for MD-80s with later model computers and MD-11s and MD-90s with fully automatic systems.

While we agree with the concept of standardization of procedures, we have concern over the future direction of this Working Group related to other FAA activities. There does not appear to exist a clear linkage of the activity to standardize noise abatement procedures to the activity currently being undertaken by the FAA/DOT to establish regulations in accordance with the Airport Noise and Capacity Act of 1990. In fact, the Working Group's recommendations and any subsequent revision to AC 91-53 could be in conflict with the Act's provisions for Stage 3 aircraft regarding airport noise and access restrictions.

We believe that additional work needs to be accomplished in the near term to allow consideration of the overall noise impact to the community as a result of any change in operational procedures, and establishment of appropriate noise criteria to be used in conjunction with standardized noise abatement procedures. We also believe the previously mentioned linkage should be established before proceeding with any further discussions of standardization.

We are currently evaluating the Working Group's recommendations and anticipate being able to provide feedback in the near future. DAC supports the establishment of standardized noise abatement procedures as well as a National Aviation Noise Policy that properly recognizes the benefit of Stage 3 technology, provided the two are synchronized towards common goals.

Sincerely,

TMRyan Jr.

T. M. Ryan, Jr.

Attachment 6

**MCDONNELL DOUGLAS**

July 30, 1991

Bill Edmunds
FAA Aviation Rule Advisory Committee
Chairman/Air Carrier Operations Subcommittee

Dear Mr. Edmunds:

McDonnell Douglas wishes to express that they are supportive of the Working Group's efforts to continue to move forward to achieve the end objective of Task 1 of the Air Carrier Operation Subcommittee.

However, after reviewing the minutes of the Task 1 Noise Abatement Procedures Working Group, the minutes of the March 13 meeting of the original Task Force are not included. MDC wishes to reaffirm the DAC position which is contained in attachments 4-1 and 4-2 of Enclosure 1 to the report of the Noise Abatement Working Group. This DAC position was again stated in a letter to Mr. Euler of the FAA on March 11, 1991 and DAC, for the record, requests that this letter be contained in the official minutes of this Working Group.

Sincerely,

W. C. Heath
Manager, Technical Liaison
Industry & Regulatory Affairs

1735 Jefferson Davis Highway, Suite 1200, Arlington, VA 22202 (703) 553-3800

Enclosure 2

# DRAFT AC 91-XX
# NOISE ABATEMENT DEPARTURE PROFILES

[Draft Revised July 24, 1991]

1. **PURPOSE**.

This Advisory Circular (AC) provides a technical analysis and description of departure profiles that are consistent with the Federal Aviation Administration's safety responsibilities and have the potential for providing abatement of aircraft noise during takeoff. This AC describes safe standard departure profiles for subsonic turbojet-powered airplanes with more than 75,000 pounds Maximum Certified Gross Takeoff Weight (MGTW), consistent with the airworthiness standards required for type certification of Federal Aviation Regulations (FAR) Part 25 and the general operational and flight rules of FAR Part 91.

2. **BACKGROUND**.

a. For several years, the FAA has been actively involved in continuing efforts to develop and provide safe and effective control and abatement of aircraft noise. As part of that commitment, the FAA has worked with airport and aircraft operators, pilots, special interest groups and other federal, state, and local agencies in numerous programs for evaluating noise levels in the airport environment. Consideration of various departure flight tracks and profiles has been included in the discussions.

b. From an environmental standpoint, whenever possible, the avoidance of departures over or near noise sensitive areas by the use of preferential noise abatement runways and flight tracks can be an effective addition to a comprehensive noise abatement program. The FAA also believes that use of standardized noise abatement departure profiles for turbojet-powered airplanes which incorporate properly managed aircraft vertical performance and which use appropriate configuration, speed and thrust management may provide additional general benefits to the airport community. Such effective noise abatement departure profiles may be used in conjunction with preferential runway and flight path techniques as well as other acceptable noise abatement measures.

c. FAA reviews of air carrier noise abatement profiles indicate that, in general, the procedures lack standardization and result in varying degrees of noise control and abatement for different points along the departure flight tracks. The management of intricate profiles is so complicated that although the departures provide noise reduction at some points along the flight track, pilot attention to interior cockpit details, required by the procedures, may divert attention necessary for traffic avoidance and other safety responsibilities.

d. In response to concerns for the development of non-standard noise abatement procedures, an operational working group reviewed available experience and, utilizing a simulator, conducted a proof of concept study of a variety of profiles, many currently employed in the national airspace system.

## 3. **RECOMMENDED NOISE ABATEMENT DEPARTURE PROFILES (NADPs)**.

Minimum criteria have been established which would permit no more than two basic types of NADPs. These departure profiles are applicable to all types of subsonic turbojet aircraft over 75,000 pounds. The basic types of NADPs are the "close-in" and "distant" profiles for aircraft over 75,000 pounds takeoff gross weight. If, for any aircraft type utilizing a specific runway in the U.S. there is not a noise benefit from the use of these standard profiles, then a noise abatement profile need not be used for that runway. It also should be understood that, at times, a normal takeoff may result in an equivalent noise abatement.

a. DEFINITIONS

1. CLOSE-IN TAKEOFF PROFILE: NADPs optimized for noise sensitive areas located in close proximity to an airport runway.

2. DISTANT TAKEOFF PROFILE: NADPs optimized for all other noise sensitive areas.

3. AGL: Above Ground Level.

b. APPLICABILITY

1. Each operator is responsible for choosing a single close-in and a single distant NADP for each aircraft type within their fleet. Additionally, either: (1) one of the NADPs, or (2) the normal takeoff procedure would have to be identified as the standard to be used for each runway at each United States airport for each of the aircraft.

2. The close-in and distant NADPs require approval in air carrier Operations Specifications* such that the single close-in NADP, single distant NADP, or the normal procedure for a given aircraft type would be applicable to a United States airport runway. As provided for in Paragraphs 4c and 4d of this AC, pilots are authorized to deviate from these procedures.

c. CLOSE-IN NADP (MINIMUM CRITERIA)
(see Figure 1)

1. A thrust cutback initiating altitude of not less than 800 feet AGL must be used.

2a. For aircraft without an operational automatic thrust restoration system, the thrust level achieved and maintained for the flap configuration of the aircraft, after thrust reduction, shall not be less than that thrust necessary to maintain the takeoff path engine-inoperative climb gradients specified in FAR 25.111(c)(3) in the event of an engine failure.

2b. For aircraft with an operational automatic thrust restoration system, the thrust level achieved and maintained for the flap configuration of the aircraft, after thrust reduction, shall not be less than that thrust necessary to maintain a takeoff path engine-inoperative climb gradient of 0%, provided that the automatic thrust restoration system will as a minimum ensure sufficient thrust restoration to maintain the takeoff path engine-inoperative climb gradients specified in FAR 25.111(c)(3) in the event of an engine failure.

* The approval process to be determined by FAA, to include Part 91 and 125 operators.

3. During the thrust reduction (cutback), the pitchover rate and thrust reduction must be coordinated to provide a decrease in pitch consistent with allowing indicated airspeed to decay by no more than 5 knots below the all-engine target climb speed, and in no case shall speed be permitted to decay below $V_2$ for the aircraft flap position achieved at the time of thrust reduction completion.

4. Maintain at least those speed and thrust criteria to not less than 3,000 feet AGL, or until past the noise sensitive area (whichever occurs first), initiate the flap retraction on the appropriate speed schedule and transition to normal enroute climb procedures.

d. DISTANT NADP (MINIMUM CRITERIA): (see Figure 2)

1. A flap retraction initiating altitude of not less than 400 feet AGL must be used.

2. Retract flaps while accelerating on the appropriate speed schedule, then cutback thrust as follows;

3. Cutback thrust may be set at an intermediate or zero flap setting. Thrust cutback may not be initiated at an altitude of less than 800 feet AGL. For each point along the flight path, the thrust shall be sufficient to maintain the takeoff path engine-inoperative climb gradients applicable in Paragraphs 3(d)(4)(a or b) of this AC for the flap configuration at each point.

4a. For aircraft without an operational automatic thrust restoration system, the thrust level achieved and maintained for the flap configuration of the aircraft after thrust reduction shall not be less than that thrust necessary to maintain the takeoff path engine-inoperative climb gradients specified in FAR 25.111(c)(3) in the event of an engine failure.

4b. For an aircraft <u>with</u> an operational automatic thrust restoration system, the thrust level achieved and maintained for the flap configuration of the aircraft, after thrust reduction, shall not be less than that thrust necessary to maintain a takeoff path engine-inoperative climb gradient of 0%, provided that the automatic thrust restoration system will, as a minimum, ensure sufficient thrust restoration to maintain the takeoff path engine-inoperative climb gradients specified in FAR 25.111(c)(3) in the event of an engine failure.

5. During the thrust reduction (cutback), the pitchover rate and thrust reduction must be coordinated to provide a decrease in pitch consistent with allowing indicated airspeed to decay by no more than 5 knots below the all-engine target climb speed, and in no case shall speed be permitted to decay below $V_2$ for the aircraft flap position achieved at the time of thrust reduction completion.

6. Maintain at least those speed and thrust criteria to not less than 3,000 feet AGL, or until past the noise sensitive area (whichever occurs first), then transition to normal enroute climb procedures.

## 4. <u>**OPERATIONAL REQUIREMENTS**</u>:

a. Authorization to use standard takeoff profiles for a specific aircraft type, which are intended to provide noise abatement benefit, should be included in air carrier Operations Specifications. No takeoff procedure may be performed to provide noise abatement unless it is authorized in the air carrier Operations Specifications. Each air carrier operating subsonic turbojet powered airplanes in excess of 75,000 pounds MGTW should make application to the FAA to amend its Operations Specifications to specifically authorize the standard NADPs.

b. This AC should not be construed to affect the responsibilities and authority of the pilot in command for the safe operation of the aircraft under FAR Part 91.3 or other regulations. The recommended NADPs do not apply when otherwise directed by ATC, and do not apply subsequent to the failure of an engine.

Enclosure 3
7/24/91

**Guidelines for Selection of Standard Noise Abatement Departure Profiles**

1. Within the minimums specified in Enclosure #1, each aircraft operator should determine the following for each aircraft type:

   A. Close-in community noise abatement departure profile (NADP)

   B. Distant community noise abatement departure profile (NADP)

2. In consultation with the airport operator, the air carrier operators should select only one NADP for each aircraft type for each runway used at U.S. airports. If, for any aircraft type, for a specific runway in the U.S., there is not a noise benefit from the use of these standard profiles, then an NADP need not be used for that runway.

3. For each NADP the altitude Above Ground Level (AGL) at which thrust reduction from takeoff thrust or airplane configuration change is initiated must be specified.*

4. The selected noise abatement departure profiles must be FAA approved for addition to the airlines's Operations Specifications.**

5. Any noise abatement departure profile for any aircraft type may be modified or replaced at any time in accordance with normal FAA approval procedures.

* Does not include gear retraction

** Airlines not authorized to use takeoff profiles not included in the Operations Specifications.

# AIRPORT OPERATORS COUNCIL INTERNATIONAL

July 30, 1991

Mr. Richard Deeds, Chairman
Noise Abatement Working Group
FAA Aviation Rulemaking Advisory Committee
C/O Mr. Wes Euler
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Dear Mr. Deeds:

On July 31, 1991, the Noise Abatement Working Group will submit its report and recommendations regarding minimum performance criteria for noise abatement departure procedures to the Air Carrier Operations Subcommittee of the Aviation Rulemaking Advisory Committee. The Airport Operators Council International (AOCI) participated in the June 26, 1991 and the July 24, 1991, meetings of the Working Group during which these recommendations were formulated. AOCI wishes to emphasize and supplement certain of the Working Group recommendations.

As Recommendation #4 of the Working Group report reflects, the "informal" FAA/Industry Working Group formed by FAA last fall, conducted a "preliminary" noise assessment of the proposed "close in" and "distant" noise abatement departure procedures using a Boeing 737-300 simulator in an attempt to identify the environmental impacts, specifically noise-related, of the procedures. The Noise Abatement Working Group recognizes that the limited test did not provide a sufficient basis upon which the Group could accurately determine noise benefit or disbenefit resulting from the proposed procedures. The Group, therefore, recommends that FAA undertake a "Phase 2" analysis of the proposed departure profiles to identify which profile "is preferable from environmental standpoints".

We concur in the need to address the noise and other environmental effects of the proposed revisions to AC91-53. The information to be developed is important if airport operators and local communities are to receive a meaningful opportunity to comment on the proposed AC revisions (and any related amendments to the Operating Certificates of the Airlines).

International Headquarters: 1220 Nineteenth Street, N.W., Suite 200, Washington, D.C. 20036
Phone (202) 293-8500 Telefax: (202) 331-1362

Telex: (Toronto) 06217827:IPS (London) 265037:IPS
(First line of message should read: "MAILBOX TO AOCI")

**NOISE** National Organization to Insure a Sound-controlled Environment

*1225 Eye Street • N.W. • Suite 300 • Washington, DC 20005 • 202/682-9386*

# MINORITY REPORT DISSENTING FROM THE REPORT OF THE NOISE ABATEMENT WORKING GROUP AIR CARRIER OPERATIONS SUBCOMMITTEE AVIATION RULEMAKING ADVISORY COMMITTEE

The National Organization to Insure a Sound-controlled Environment (NOISE) respectfully submits this minority report, dissenting from the close-in (flaps down) and distant (flaps up) standard takeoff profile procedures developed by the Noise Abatement Working Group, based on the concerns outlined below. NOISE is an association of local government officials most of whose communities are impacted by noise from airports operated by other entities. Consequently our chief goal is to abate airport noise and certainly to prevent any increase in noise that would bring more people into the 65 Ldn contour.

To achieve this end our member governments have worked together in their own regions with counterpart municipalities and with airport operators, both through the Part 150 planning process as well as through implementation of land-use policies designed to minimize the impact of airport noise on citizens. Our commitment to noise relief takes second place to only one other consideration, and that is our commitment to safety. All members of NOISE firmly believe that safe operation of aircraft is and ought to be the primary consideration of federal regulators, the airlines, the aircraft manufacturing industry, the pilots, and the communities.

The proposal of the Federal Aviation Administration to publish an Advisory Circular mandating standardized noise abatement takeoff profiles nationwide has been presented chiefly as a safety issue. Hence NOISE has come reluctantly to the conclusion that it must dissent from the recommendation of the Working Group. However, our dissent should not be viewed as a lack of concern for safe air carrier operations. We want to reiterate our firm commitment to safety. But we also want it understood that we have not seen objective data showing conclusively that current procedures are unsafe. In the absence of such evidence, we are concerned that the line between what is unsafe and what is safe but inconvenient for the airlines be clearly drawn.

Much prior effort by an informal working group of FAA and industry representatives has gone into this proposed AC, and we are told that it is imperative that the AC be published as soon as possible in order to improve the safety of air carrier operations and impose standardization on what is described as a proliferating array of local procedures. It has been extremely difficult for NOISE, in only two meetings of the Noise Abatement Working Group, to grasp the implications of the proposed AC and attempt to master material that was before the informal working group for two years, as well as grapple with the implications of the safety issue, amid the sense of urgency that has prevailed.

NOISE is deeply concerned that the intention of FAA is to rush into effect a mandatory policy affecting every airport in the United States without conducting a prior evaluation of either the environmental or the operational impacts of that policy. When the AC is implemented, each airline may select either a close-in or distant profile for each type of aircraft in its fleet for use on each runway at each airport it serves. Different carriers could choose differently between the close-in or distant options regardless of the actual distribution of land uses around the airport.

While some simulations have been done, no actual testing of the effect such choices will have on major airports has been carried out. But logic suggests that the policy would simplify procedures for the airlines while complicating them for the airports, who must accommodate a mix of airline procedures which, from the airports' point of view, would be more nonstandard and proliferating than the airport procedures the carriers currently complain of. Whether they would be unsafe also is anybody's guess. These problems would not necessarily be corrected by language NOISE asked to be inserted in the draft AC requiring airlines to confer with airports before making their selection of procedures.

It is readily admitted by the proponents of the draft AC that its noise impact on communities around airports cannot be foreseen with accuracy, though the simulations are said to suggest that existing noise levels will not be worsened and industry representatives offer similar assurances. But again, logic suggests that replacing a procedure at a given airport that all carriers must follow with an array of procedures that each carrier has selected will, at the very least, redistribute the net noise and impose on surrounding communities a different pattern of noise impacts. Also unclear is the extent to which individual airports have in place vertical profiles which are a part of their Part 150 plans that might be affected by the new pattern of profiles.

Clearly it would not be desirable to implement a public policy that expands the 65 Ldn contour - again, unless safety considerations demand it, as appears to be the case at Orange County Airport. Yet no evaluation has been done, and none is apparently proposed to be done on a comprehensive basis, prior to publication of the AC, to determine its likely noise impact. NOISE questions whether it is even permissible under the Administrative Procedures Act to issue an AC without having performed a prior environmental and operational assessment.

The AC is to be published in the Federal Register with a comment period, but in the absence of evaluation data on environmental and operational effects, it is hard to see how communities can have access to information leading to useful comments. Thus the comment period will necessarily be of limited value. Furthermore, NOISE admits to a degree of confusion regarding the vehicle chosen to implement the standard departure profiles. Our understanding is that an AC is just what the name implies, advisory in nature, not mandatory in the sense of regulation. Yet the content of the draft AC is clearly mandatory. This raises the question whether in fact FAA is attempting a rulemaking by another name and, if so, whether it is following appropriate procedures.

For the reasons above stated, NOISE recommends that publication of the AC be delayed pending testing at selected major airports to determine environmental and operational impacts, and that the results of such tests be released at such time as the draft AC is published for comment.

Charles F. Price
Executive Director

July 30, 1991

# Metropolitan Washington Airports Authority

July 26, 1991

Mr. Charles F. Price
N.O.I.S.E.
1225 Eye Street, N.W.
Suite 300
Washington, D.C. 20005

Re: Draft proposal for FAA AC 91-XX

Dear ~~Mr. Price~~ Charlie:

Thank you for giving me an update on the FAA Aviation Regulatory Advisory Committee's efforts to draft an advisory circular addressing departure profiles. We are most interested in closely tracking this task to its conclusion.

Washington National Airport has a special noise abatement departure profile which has been in effect since the first turbojets began scheduled service into Washington National in 1966. Our departure procedure request that aircraft climb to 1500 ft. under full climb power and then reduce thrust ( to a setting which provides approx. 500 fpm on a hot day). Once the aircraft are beyond the 10 DME arc reapplication of climb power is allowed. This procedure was designed, tested and implemented by the FAA prior to the beginning of scheduled jet service into Washington National.

We are concerned that adoption of the proposal as drafted would lead to a variety of flight profiles less effective than the current procedures. These concerns are heightened by the possibility that the advisory circular may be developed in advance of any real consideration of the potentially adverse impacts to the noise situation surrounding Washington National and other airports.

If I can be of any assistance to you on this matter please let me know.

Very truly yours,

Neal
Neal Phillips
Manager, Environmental Staff